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MIDLAND ASSOCIATION

BY devoting its whole meeting last Thursday to a joint discussion with members of the Midland Branch of the Institute of Sewage Purification on Mr. E. H. M. Badger's Institution research meeting paper on liquor disposal, the Midland Association of Gas Engineers and Managers gave the district associations a further lead. One of the main arguments advanced in favour of changing the district associations into district sections of the Institution of Gas Engineers is that it will encourage discussion, at district level, of papers of common interest to gas engineers throughout the country for which there is seldom adequate time at the meetings of the Institution. The idea is not entirely novel, but it has been only on rare occasions that Institution authors have gone personally to the districts to help in the further examination of the subjects they have raised. Mr. Badger's visit to Birmingham may probably prove to be the last of its kind under present auspices. It certainly afforded a preview of the advantages to be gained from an extension of the practice in the future.

No more appropriate subject could have been chosen for the occasion than that dealt with by Mr. Badger, for the Midland Association in general, and the West Midlands in particular, have been seriously concerned with the effluent problem for many years. The Hinckley undertaking, under the management of Mr. A. B. Britton, encountered considerable difficulties in connection with the disposal of its liquor some years ago, and the account which Mr. Britton gave in his Presidential Address to the Midland Assocation in 1945 of the improvement in the quality of the liquor discharged to the sewers resulting from carrying out the recommendations of the Liquor Effluents and Ammonia Committee of the Institution was particularly noted in Mr. Badger's paper The value of Thursday's meeting was enhanced by the presence—and participation in discussion—of what Mr. T. F. E. Rhead described as the most representative gathering he had yet seen on the subject, comprising representatives of river boards, the Institute of Sewage Purification, and the D.S.I.R., in addition to the Association's own members. Members and visitors welcomed the free exchange of views and expressed the hope that what had been done in the Midlands would be extended to other parts of the country. Mr. Britton made a special plea for early action in the appointment at high level of a joint committee of all those concerned—all seeking to render a useful public service in their own spheres—with district joint committees to deal with the more localised aspects of the problem. A whole afternoon proved not a moment too long for the discussion. The Association was wise in deferring the other paper originally on the agenda to a further meeting next month.

PROFIT IN KILOWATTS

IN its first year of nationalisation the British Electricity Authority has made a net profit, after meeting its interest charges, of £4,391,684. The fact that electricity is thus the first of the major industries recently acquired by the State to have paid its way in its first year attaches a degree of political importance to the publication of the B.E.A.'s report last week, a review of which is to be found in later pages of this number—an importance which is naturally enhanced by the imminence of the General Election. In itself, however, the surplus achieved is no more than evidence of ordinary accounting competence in estimating what charges would have to be made for electricity in order to cover the costs. The fact that the surplus is a matter of relief serves to show at what a low ebb, after the experience of coal and transport, are the standards of performance expected from the State industries which no party proposes to return to private enterprise.

Of far greater significance, and of more interest to the gas industry, is the increase which is revealed in the report of no less than half a million consumers during the year under review. Total sales rose by 10% ; those to industrial consumers by 9.5%, and those to domestic consumers by 8.2%. This, no doubt, can be attributed to the continuing low price of electricity. Although the charge for each unit of electricity sold during the B.E.A.'s first year was 4.7% higher than in the previous year, the cost of electricity for the domestic consumer was still 9% lower than before the war. It should nevertheless be borne in mind that the average annual increase during the previous 10 years has been approximately 0.8%, and future increases at the rate of 4% would not be regarded with equanimity. It is, of course, true that the price of coal went up during the year, but the rise was only slightly more than in previous years.

The authority is at pains to explain that a part of the abnormally large increase was due to the fact that increases which would otherwise have been introduced by the former undertakings were delayed by the proximity of nationalisation.

The report has much to say on its plans for the future; equipment is to be standardised, tariffs are to be rationalised, and rural electrification is to be tackled. But on the real questions of interest—the price of electricity to the consumer and the provision of adequate generating capacity—the B.E.A. has to confess that they are largely beyond its own control. The report makes it clear that as long as capital charges remain high and are not offset by increasing technical efficiency and expanding sales, prices may not be held down to their present level. The electrical industry faces very much the same problems as the gas industry; new plant which is under commission is costing about three times as much as pre-war; the inland price of coal may well go up when the Coal Board has to reduce its export prices; and the impending rise in transport rates may well produce an additional increase.

The severity of the plant shortage is indicated by the difference between the new plant planned and that actually brought into operation. Of the 3,051,000 kW which it was hoped to bring into operation in 1946, 1947, and 1948 it was possible only to commission 1,042,000 kW. Output capacity of generating plant actually commissioned rose from 340,000 kW in 1947 to 566,000 kW in 1948, and, according to recent estimates, to 700,000 kW in 1949. Future plans envisage some deficiency until the winter of 1953-54 and assume the retention of much obsolescent plant in service for many years to come. It is therefore likely that the anticipated rises in costs will outweigh the economies which will be effected by future technical improvements. The mildness of this winter, following the mildness of the weather last year, may have created the illusion that the problem of the electrical industry is nearer solution than it is. There is, on the contrary, every reason why the next Government, whatever its party affiliations, should give the closest attention to both the efficiency and costs of the service.

HOT WATER IN THE HOME

WE have followed closely in these pages over the past 18 months the work being carried out at the Building Research Station of the Department of Scientific and Industrial Research on the heating of houses. Another chapter has now been added to the story by the publicaton in our issue today of an abstract of a paper on domestic water heating which Dr. J. C. Weston, of the Building Research Station, presented to the Institution of Heating and Ventilating Engineers a fortnight ago. We were present at the meeting and were impressed both by the freshness of the author's approach and the volume of discussion which it evoked. The prelude to Dr. Weston's analysis of the latest figures for hot water consumption and costs with the various appliances in use at Abbots Langley is of prime importance. It comprises some of the results of an investigation into the distribution of appliances and the use of hot water recently undertaken by Social Survey for the Ministry of Works and as yet unpublished. These show that only 36% of households have hot water piped to the sink, wash basin, and bath; 44% do not have hot water piped to any point, and only 54% have access to a bathroom. Such findings serve not only to illustrate the magnitude of the improvements required in existing dwellings; they are also a revealing backcloth against which the work and results at Abbots Langley have to be set. Dr. Weston was careful to emphasise this, and a number of those who contributed to the discussion also stressed the need for a greater consideration of the social aspects of the problem. Concern for the consumer's pocket is more than ever necessary today, and we were therefore happy to find that the paper gave evidence of the greater savings which can accrue by the use of gas for hot water heating in the summer months. Elementary as this may seem, it is a fact which as yet has not been fully recognised, least of all by the Ministry of Health in its new and revised version of the Housing Manual.

A TEAM EFFORT

DISTRIBUTION of the 1950 edition of the *Gas Journal Calendar and Directory* now in progress marks the consummation of a considerable effort in which innumerable people on all sides of the industry willingly co-operated with our own staff in adapting a familiar, popular, and valuable publication to the new order. Nationalisation of the gas industry rendered the former directory of undertakings obsolete not only in titular detail but in general construction. Hence we have scrapped the two-page spread tabular layout. Now the particulars of works, address, chief officials, plant, number of consumers, and price of gas have been presented in more compact form for speedy and accurate reference. Until this year the directory has treated the industry as a national concern with all undertakings arranged alphabetically. Nationalisation, however, has accumulated undertakings into areas, but through decentralisation these areas have been broken up into divisions and districts. In the new directory, therefore, all the undertakings are shown in their respective regionalised 'compartments.' This grouping alone might have rendered it more, rather than less, difficult to turn up a particular undertaking, but our plan of giving a full index to towns supplied with gas—whether possessing local gasworks or not—speeds the process. The personnel section covers a wider field than before, and all in the new set-up, from the Gas Council down to the gas consultative councils, are named. Other features of the new edition, which it is not our purpose to elaborate here, have been thoroughly revised and are, we think, unique.

With the continuous changes, subscribers will, of course, recognise that it has not been possible to achieve complete accuracy in the new directory. Even where particulars were checked at the time of going to press there have been subsequent changes, and for those changes we cannot be expected to apologise.

The point we would make is that it is only with the co-operation of members of the industry—and especially of unit, district, divisional, and headquarters officials of the area boards—that we can hope to keep up to date the in-

formation which everyone connected with the industry needs. Throughout this year we shall publish particulars of latest changes in the first issue of the 'Journal' in each month. The first of these lists will appear next week. The real usefulness of the book to the industry as a whole will depend on the extent to which individuals help us to keep it constantly revised and take the slight trouble involved in correcting, as changes are announced through our columns, their individual copies of the directory. We appeal to every reader to co-operate in this piece of service to the industry.

AUSTRALASIAN SALES

COMPILED and issued by the Statistical Department of the National Gas Association of Australia, the 1948 Statistical Year Book of the gas industry in Australia and New Zealand shows that in spite of difficulties in the supply of coal and other materials sales of gas by Australian gas undertakings in 1948 were considerably higher than for 1947, and gas was made available to many new consumers. Gas sales reached an estimated total amount of 32,030 mill. cu.ft., exceeding sales for 1947 by 4.7% and for 1939 by 68.8%. The total number of meters in commission at the end of 1948 was approximately 1,113,000, against 1,092,000 in 1947 and 903,000 in 1939. Sales of coke, totalling 735,000 tons, were 5.8% above the 1947 figure, and 55.7% above that for 1939. Tar sold or treated was estimated at 31,880,000 gal., or 5.8% higher than for the previous year and 62.7% higher than in 1939. Coal carbonised at 1,947,000 tons, was 3.5% above the quantity carbonised in 1947 and 63.6% more than in 1939. The average number of persons employed in Australian undertakings during the year was 11,100, 220 more than in 1947 and 1,360 more than in 1939. New Zealand undertakings sold slightly less gas in 1948 than in the previous year, but the 4,750 mill. cu.ft. sold was 30.9% higher than in 1939. Statistics for the year were supplied by all undertakings in Australian metropolitan areas and by 60 provincial undertakings which represented 87% of the total make in provincial areas. Eighteen undertakings, representing 85% of the total gas manufactured in New Zealand, also supplied statistics for the year book.

CENTRAL 100

LITTLE more than two years ago there passed without notice the jubilee of an important event in the history of the City and Guilds College—the foundation in 1897 of the Central Technical College Old Students' Association, or the Old Centralians as they are now called. After less than six years, however, it was found that the success of the College was helping towards the undoing of the Association. Graduates were being sent far and wide, and occasional functions were insufficient to maintain the bonds of membership. The solution appeared in 1903 with the *Central*, a magazine, the aims of which were to be of interest to the Central student past, present, and future, and to 'be worthy of the College and serve as a permanent record of the valuable work it is doing.' We have now received No. 100 of the *Central*, which boasts a new cover, heraldic in character as were its predecessors, and 74 pages of text, plus pictorial pages on art paper—altogether an impressive production and a credit to its editor, Mr. J. W. Voeliker, and his colleagues. The issue is frankly historical in content, reproducing past editorials, and including short histories of the magazine, the City and Guilds of London Institute, and a number of admirable photographs. In particular we enjoyed an illustration of the first vacuum cleaner, whose prodigous weight was borne on a heavy trolley, and an aged menu including such items as 'high tension cheese with Ayrton biscuits' and 'Gillet safety cigarettes.' In congratulating those responsible on a fine publication with a fine record, we would express our admiration of the remarkable advertisement section, a rarity in magazines of this type which must assist considerably in lightening the financial burden on its sponsors.

INSIGHT INTO INDUSTRY

THE academic atmosphere and comparative isolation of our universities have provided a perennial problem at the conclusion of each academic year in the selection of those posts for which the individual student is most suitable in temperament and training. The establishment of University Appointments Boards at the end of the war was both a recognition and an attempted solution of this difficulty. They do not, however, forearm the graduate with any practical knowledge of the job in which he is ultimately placed. The vacation work scheme of the Imperial College of Science and Technology has provided such experience for its students for the past 15 years, and it is satisfying to learn from the annual report of the scheme for the past year that 'it is now a widespread and accepted service to all our students, while numerous enquiries are received from other institutions regarding the principles adopted in its operation.' More important is the fact that 'to an ever increasing extent' industrial managers and directors of research in industry are utilising the vacation work as a testing period to enable them to select suitable staff from among students, prior to the completion of their studies. Over 500 students of the College—from the Royal School of Mines, the City and Guilds College, and the Royal College of Science—registered for practical experience during last year's summer vacation, including 149 who elected for experience in industry abroad under the International Association for the Exchange of Students for Technical Experience. A list of 200 companies and industrial organisations which offered their co-operation to the scheme during last summer is thoroughly representative of British industry, and includes, together with many names familiar to the gas industry, the British Coal Utilisation Research Association, the Department of Scientific and Industrial Research, the Gas Research Board, and the North Thames and South Eastern Gas Boards.

SCIENTIFIC AND TECHNICAL EXCHANGE

FOR the past six months the 18 member countries of the Organisation for European Economic Co-operation have been discussing ways and means by which co-operation in the scientific and technical fields can be achieved, and one of the major problems has been to ensure that scientific and technical information published in all countries will be available to industry. Their deliberations have resulted in a scheme which was introduced on New Year's Day for the exchange of scientific and technical Government publications between member countries. Up to date, Austria, Denmark, France, Holland, Italy, Norway, and the United Kingdom have agreed to participate, and it is understood that other countries will join shortly when their arrangements have been completed. This first step towards a complete system for the interchange of scientific knowledge and ideas provides that each Government concerned will supply to the others up to six copies, free of charge, of all Government documents, published on or after January 1, which deal with aspects of the physical and biological sciences appertaining to industry, any branch of technology, medical matters of industrial interest, and economic and statistical information on industrial productivity. Each country in the scheme has agreed to establish a central clearing house which will select and despatch outgoing reports and will handle the distribution of incoming documents. In this country the work will be undertaken by the Technical Information Documents Unit of the Board of Trade at 40, Cadogan Square, S.W.1. The unit will compile selective lists of 'imported' documents according to their subject-matter, and where necessary explanatory sub-titles will be appended. Relevant lists will be supplied to the various research and trade organisations, and will also be available to technical and scientific journals. The original documents will be retained at Cadogan Square where they will be accessible for reference purposes, but it is also intended that other information centres in other parts of Britain shall be opened, and it may ultimately be possible in certain circumstances to borrow a document for a short period. The Governments in

the scheme have agreed to relax the copyright laws relating to these documents in order that the receiving authority may arrange for single reproduction of any publication to be supplied on a non-profit making basis. Apart from this particular concession, the use of the information received will be subject to the receiving country's laws of copyright and industrial property.

Personal

Mr. **Charles A. Smith,** A.S.A.A., M.S.I.A., was presented by Gas Council colleagues with a silver coffee pot and their best wishes on the occasion of his departure to become General Manager of a group of companies concerned with agriculture and market gardening. The presentation was made by Mr. W. Bailey, Chief Accountant (left). Mr. Smith joined the British Commercial Gas Association in January, 1939. He served with the 15th Scottish Division of the Royal Artillery in the N.W. Europe Campaign, and on demobilisation in December, 1945, was appointed Accountant to the British Gas Council.

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Mr. **Kenneth G. Holden,** Chairman of Hardman and Holden, Ltd., has been appointed a director of Williams Deacon's Bank, Ltd.

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Mr. **James E. Scott,** Technical Assistant at Leven gasworks, was recently presented with a travelling bag from fellow employees on leaving to join the Aberdeen undertaking.

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Mr. **J. C. Kinoulty,** Deputy Town Clerk of Bilston since February, 1947, has been appointed Assistant Solicitor to the West Midland Gas Board—a new appointment.

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Mr. **Wilfred Brown,** Assistant Engineer and Manager of the Falkirk undertaking, has been appointed by the West Midlands Gas Board as Engineer and Manager of the Leek undertaking. He received his training at Leven, Fife.

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Mr. **J. W. Brearley,** of Swinton, local Manager of the East Midlands Gas Board, and before nationalisation Engineer and Manager of the Swinton and Mexborough Gas Board since 1914, retires this month. He has been Chairman of the South Yorkshire Gas Group and Vice-Chairman of the Yorkshire District, British Commercial Gas Association.

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Mr. **J. M. Brown,** Works Manager at the Athol Street works of the Liverpool undertaking, has taken up an appointment with the West Midlands Gas Board, and Mr. **G. Gilden** has succeeded him at Athol Street. Mr. **C. W. Hemingway** has been appointed Works Manager at Wavertree and Mr. **K. Lord** Deputy Works Manager at Linacre. Mr. **J. E. Powers,** who was Comptroller, has taken up the post of Group Accountant to the Liverpool Group ; and Mr. **W. Spelman** is now with the Wales Gas Board. Mr. **S. W. Hayes,** District Distributing Engineer, has been appointed Distribution Engineer to the North Devon Sub-Division of the South Western Gas Board, and Mr. **J. E. Funk,** Ormskirk, has been provisionally appointed Sales Manager to the Leyland and Chorley undertakings. Mr. **H. Naylor** is now assistant distributing engineer of the Liverpool undertaking.

Mr. **R. S. Ramsden,** who retired from the position of General Manager and Engineer of the Leamington Spa District, West Midlands Gas Board, on November 18, was presented last month with a set of tables. The gift was made on behalf of the staff and employees of the undertaking, and in returning thanks for the presentation, Mr. Ramsden referred to the many happy associations and friends he had made during his 31 years of management at Leamington Spa.

Obituary

Mr. **A. Glynne Lobley,** Managing Director of Birlec, Ltd., Erdington, Birmingham, died on January 16.

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Mr. **James E. Eadington,** who succeeded his father as Engineer and Manager of the Blyth Gas Company in 1895, and remained in that position until his retirement in 1941, died on January 8. He was 75 years of age.

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Mr. **Walter B. Hudson,** a former representative of George Glover & Co., Ltd. (Radiation Ltd.), died in December at the age of 82. Mr. Hudson joined the firm in 1901 and maintained his interest in the firm until shortly before his death.

Diary

Jan. 26.—Midland Junior Gas Association: Visit to works of British Thomson-Houston, Ltd., Rugby.

Jan. 26.—North Thames Gas Consultative Council: St. Ermin's Hotel, Westminster, S.W.1, 2.30 p.m.

Feb. 3.—Scottish Junior Gas Association (Western District): 'Gas Conversions to Commercial Apparatus,' A. Walker (Motherwell); 'Difficulties in Handling Inferior Fuels,' G. W. Laing (Barrhead).

Feb. 10.—London and Southern Junior Gas Association: 'Heat and Water Vapour in Crude Gas,' F. E. Craddock (Research Laboratory, Fulham Works, North Thames Gas Board). Lecture Theatre, North Thames Gas Board, 178-180, Edgware Road, 7 p.m.

Feb. 11.—Midland Junior Gas Association: Dinner and Social Evening. Imperial Hotel, Temple Street, Birmingham, 6 p.m.

Feb. 13.—West Midlands Gas Consultative Council: Meeting, Birmingham, 2.30 p.m.

Feb. 13.—Women's Gas Council : Finance Committee, Gas Industry House, 12.30 p.m.

Feb. 14.—Scottish Junior Gas Association (Western District): Evening visit to Hoovers, Ltd., Cambuslang.

Feb. 14.—Midland Junior Gas Association: 'Civil Engineering Contracting for the Gas Industry,' W. H. G. Roach and R. Y. Stevens (Wm. Press and Son, Ltd.).

Feb. 16.—Midland Association of Gas Engineers and Managers : 'Making the Best Use of Existing Plant and Providing Extensions with Maximum Economy,' S. K. Hawthorn. Queen's Hotel, Birmingham, 2.30 p.m.

Feb. 18.—Yorkshire Junior Gas Association: Three Short Papers, F. E. Lodge, M. Williams, and R. Hodgson. Bradford.

Feb. 22.—London and Southern Junior Gas Association: Visit to Meter Repair Works.

Feb. 25.—Western Junior Gas Association: Joint Meeting with Wales and Monmouthshire Junior Gas Association. 'Mainlaying,' R. McAfee (Bath); 'Coke Oven Practice,' J. V. Drake (Bedwas); 'Comparative Performance of Iron Oxides,' A. G. Gaston (Bath).

Feb. 25.—Scottish Junior Gas Association: Joint Meeting of Eastern and Western Districts. Morning visit to Falkirk Gasworks. Afternoon meeting, 'The Administration of the Scottish Gas Area,' Sir Andrew Clow, Chairman, Scottish Gas Board. Falkirk Gas Showrooms.

Mar. 20.—Women's Gas Council : Executive Committee, 1 p.m. Headquarters Members' Meeting, 3 p.m. Gas Industry House.

Mar. 20-21.—Women's Gas Council : Branch Conference, Gas Industry House, 3 p.m.

News in Brief

The Offices of the Southern Gas Consultative Council are now at 132, Old Christchurch Road, Bournemouth (Telephone: Bournemouth 7020; Chairman, extension 42; Secretary, extension 47).

An Error occurred on p. 150 of last week's issue of the *Journal*. It was stated that the paper, 'The Design and Organisation of an Exhibition Stand,' was presented by C. E. Williams. The author was, in fact, L. T. J. Hands, Chairman of the Midland District Circle for the present session.

The Village of Blairhall, in Fife, will shortly be linked for gas through Culross from the Dunfermline gas undertaking. To mark the start of pipelaying the Scottish Gas Board staged a two-day exhibition of gas appliances in the Miners' Institute at Blairhall, at which Mr. James Campbell, Scottish Gas Board, Mr. David L. Dickson, Manager of the Fife Group, and Mr. William Anderson, Manager, Dunfermline Gas Showrooms, were present. It is expected that the village will be fully serviced by the autumn.

West Hartlepool Town Council is opposing new charges for gas street lighting proposed by the Northern Gas Board, which will increase gas charges by 56%. Prior to nationalisation, the board state, street lighting charges at West Hartlepool were not economic. At a Press conference, the Town Clerk (Mr. E. J. Waggott) stated that they were the first authority to be dealt with by the board, but they would refuse to be used as a spearhead for an attack on local authorities. It is understood that Scarborough Corporation has also rejected new street lighting charges.

The Minister of Supply, the Rt. Hon. G. R. Strauss, Esq., P.C., M.P., accompanied by a party of five, including Mr. F. C. Wake, Regional Controller, Ministry of Supply, visited the Stockton works of the Power-Gas Corporation, Ltd., Ashmore, Benson, Pease and Co., Ltd., on January 11. The Minister, accompanied by Major W. R. Brown, D.S.O., Mr. R. W. Rutherford, and Mr. W. R. Beswick, directors of the two companies, inspected the research laboratory and toured the various departments of the works. During the course of his visit he saw a model of the proposed new works, representing the companies' planned extensions over a 100-acre site.

The Annual Conference of the organisers of the exchange of students met at the Finland Institute of Technology in Helsinki from January 9 to 13. Representatives of the following countries were present: Austria, Belgium, Denmark, Finland, France, Great Britain, Holland, Italy, Norway, and Sweden. Observers were sent by United States and Germany. The United States and Germany were admitted to the Association and will interchange students during the summer of 1950, for which arrangements were made for the interchange of 1,700 students, compared with 1,236 in 1949. Under special conditions it was agreed to include students of commerce, agriculture, and architecture in the Association's programme for 1950.

The Annual Dinner and Dance of the Combustion Engineering Association will be held at the Dorchester on March 16, at 6.45 for 7.15 p.m. Application for tickets (45s.) should be addressed to the Secretary, 24, Tottenham Court Road, London, W.1.

At the Invitation of Mr. R. C. Arnold, Manager of the Spalding Undertaking, East Midlands Gas Board, an instructional talk to the fitting staff was recently given by Mr. James C. Thomas, technical representative of Main Water Heaters, Ltd., on the constructional features, installation, and maintenance of the Thermain No. 2 sink storage and the Thermain No. 15 multipoint storage water heaters.

To Maintain Coal Output during 1950, a Dunlop team worked through the Christmas holiday, 1,200 ft. down, installing one mile of main trunk conveyor belt in Barrow Colliery, Yorkshire, to carry the coal from the face to the tubs. The complete belt, supplied to the colliery in six rolls 8 ft. in diameter, weighed 24 tons, and the job was done in time for the miners when they returned to work.

According to the Report on Companies, issued by the Department of Industry and Commerce in the Republic of Ireland, for the year ended December 31, 1948, there were on that date 18 companies in operation as owners of gasworks, with a total nominal share capital of £198,540, of which £172,421 had been paid up. Five of these were private companies with a nominal share capital of £34,500 of which £23,928 was paid up. The 13 public companies had a nominal share capital of £164,040 of which £148,493 was paid up.

Billingham-on-Tees Urban District Council, which has refused to pay 65s. per house to the Northern Gas Board for laying gas pipes from garden gates to the gas meter, has been informed by the board that unless the Council agrees to the scheme the board will have to increase its gas charges to cover the cost. Although the board has informed the Council that other authorities have agreed to pay the extra charge, the Clerk to the Council stated that certain authorities had not been asked to pay. The Council is discussing the matter further with the board.

Raising the School Leaving Age has facilitated development of housecraft and domestic science training. Modern schoolgirls find in these spheres a fascinating new world of experiment; they find, too, in many cases, useful New World gas cookers to simplify their culinary tasks. One group of undertakings controlled by the North Western Gas board is presenting copies of the new Radiation publication, *Recipes for Today the New World Way,* to all the housecraft students in its area. Fortunate recipients should have no difficulty in answering such questions as the following (recently included in a school's general knowledge test paper): 'Which gives the hotter oven, Regulo 3 or Regulo 7?'

We Have Received from International Combustion, Ltd., 19, Woburn Place, London, W.1, a booklet which describes the Ferloy series of Vacseal pumps. As distinct from the rubber-lined series, these are specially designed to handle non-corrosive abrasive pulps and suspensions of larger solids for which rubber is unsuitable. The pumps are designed in two models, the vertical spindle type for use in pit or sump with arrangements for direct motor drive with or without extended spindle, and the horizontal spindle type for direct coupling to electric motor, or with extended shaft for 'V' belt drive. A marked saving in operation and lower all-in costs are attributed to extreme simplicity of the design and freedom from gland troubles. The pumps are made in sizes from 2 to 8 in. to handle quantities ranging from 30 to 2,500 gal. per min. against a total head of 100 ft.

Coal Prospects for 1950

The net profit of the National Coal Board for last year was estimated by Lord Hyndley, the Chairman, as 'in the neighbourhood of £10 mill.' Lord Hyndley, who was speaking at a luncheon in London on January 19, added that in computing this profit, allowance would have to be made for a possible increase in liability for workmen's compensation cases arising before July 8, 1948, and for a special taxation reserve. He said: 'The year's profit has depended, like the previous year's, on the favourable prices in the export market. Further, the board has also to meet the full increase in costs arising from devaluation and probably increases in railway rates. There remains, therefore, the vital problem of reducing production costs to and below the level of inland prices.' They had still more than half the 1947 deficit to eliminate.

There was every indication, he continued, that the export market for 1950 would remain generally good, with no great difficulty in disposing of the coal available. An export target had been set of more than 22 mill. tons, an improvement of 3 mill. tons over 1949.

Lord Hyndley said that a 'realistic forecast' of deep-mined output for this year might be 205 to 210 mill. tons, compared with an actual output last year of 202,700,000 tons. He thought that output per manshift would increase as the board's schemes of reorganisation were carried out. On the major problem of the persistent fall in manpower Lord Hyndley saw no need for a special recruiting campaign. 'At present,' he said, 'the figure is 709,000. Whether last year's decline will continue, we cannot say, but we shall probably finish the year with about 700,000 men on the books. If the total declines then we can expect the number of faceworkers also to decline.' He described the 1949 absenteeism figures as 'disappointing,' but the increase in output per manshift 'has encouraged everyone,' an achievement which he attributed largely to reorganisation and the redeployment of men from uneconomic pits.

The First Year of State Electricity

Revenue Surplus, Record Output, Increased Prices

THE first report and statement of accounts of the British Electricity Authority, covering the period August 13, 1947, to March 31, 1949, which were published last week (Stationery Office, 5s. 6d.), show that the industry as a whole has recorded a surplus of £4.39 mill. since vesting day, April 1, 1948. The B.E.A., which is responsible for supplying electricity to the area boards, showed a deficit of £607,149, representing 0.5% of the Authority's gross revenue, on its own transactions. In order to make good this deficit on the Authority's accounts, and at the same time to form a nucleus of the Central Reserve Fund, the 12 area boards with net surpluses have been called on to make contributions to the Central Reserve Fund. The surplus, states the report, is by no means large in relation to the combined revenues of £197.6 mill., but it can be regarded on the whole as a satisfactory outcome of a year which has not been free from stresses and strains such as rising costs of labour and materials, load-shedding and user restrictions, which have limited sales expansion and revenues, and the development of new ancillary services in education, welfare, and labour relations.

Increased Generating Capacity

In view of the greatly increased capital costs of construction which have now to be met, the report continues, it is clear that capital charges will grow in relative significance, and that unless offset by increasing technical efficiency, coupled with expanding sales, the growing burden of capital charges may necessitate higher tariffs.

The B.E.A. generated 46,243 mill. units of electricity in its first year of operation, an increase of 10½% over that of the previous 12 months, and nearly double the 1938-39 quantity. The authority's generating capacity at the end of last March was some 12,900,000 kW, but a tenth of the 906 generating sets vested or operated under the control of the authority is 25 years old or more, including 23 which were installed between 45 and 50 years ago. Some of the plant is so small that three-quarters of the generating stations run by the B.E.A. produce only a tenth of the total output. Last year the difference between peak demand and available capacity was 531,000 kW, and load shedding had to take place on 79 occasions. Plant with an output capacity of 566,000 kW was installed in 1948, compared with 340,000 kW in 1947 and 307,000 kW in 1946, but 'the rate of production of plant was far short of that required to meet the programmes.' The report states: 'The magnitude of the authority's future plant extension programmes is governed by the capacity of new generating plant which can be made available, rather than by the amount of plant which is considered necessary to meet the expected load.' In consequence, the report continues, it will be necessary, for the next five years at least, to continue to make use of all serviceable plant regardless of its age or relative efficiency; and for several years thereafter the removal of obsolete plant from service will be possible only on a limited scale.

The number of consumers at the end of the year was nearly 12,200,000, which was some 500,000 more than at vesting day and upwards of 2 mill. more than were supplied by the former electricity undertakings before the war. Total sales to consumers by the area boards exceeded 39 mill. units—a tenth more than the corresponding figure for 1947-48 and almost double the corresponding quantity sold in 1938-39. Half the sales were to industry and over a third to domestic consumers. Supplies were connected to some 8,700 farms during 1948-49, as well as to villages, rural industries, and cottages. Sales of energy to industrial consumers increased by no less than 9.5%, and the relaxation on street lighting restrictions and the general resumption of street development resulted in a 43.4% increase in sales for public lighting purposes, although total sales were still considerably below pre-war level. On the other hand, the restrictions imposed on the provision of new supplies to consumers, together with the reduced rate of house building, considerably affected growth in the domestic field. Total sales to domestic consumers increased by 8.2%.

District Heating Problems

A section in the report on district heating records that the B.E.A. gave close attention to this question, more immediately in relation to the provisions of certain Local Acts which empower the local authorities to undertake schemes for the provision of district heating by means of hot water or steam. The authority, the report states, regards sympathetically such schemes which enable the local authorities to construct thermal-electric stations for the generation of electricity incidentally to the production of heat. The Central Authority is required to purchase at agreed or arbitrated prices any electricity so generated, other than required for or in connection with the supply of heat. The authority point out, however, that a characteristic of the schemes is the fact that the thermal-electric stations are primarily producers of heat, with electricity as a by-product. Heat is produced in the quantities and at the times required to meet the space-heating and hot-water needs of the district, and there are thus wide variations in the quantities of electricity available. This leads to difficulties in system operation, and the lack of balance between the demands for heat and electricity detracts from the economic value of the electricity supplied from the station. The problem is illustrated by the Manchester project at Wythenshawe. Here, the authority gave close consideration to the proposal and offered special terms for a limited period, but the Manchester Corporation have not yet decided whether to proceed with the scheme. Arrangements were concluded with Westminster City Council for the supply of steam from Battersea power station to their Pimlico scheme; negotiations were taking place for the supply of heat to Swindon Corporation, and discussions were being held with Stevenage Development Corporation on the extent of their schemes.

Average Revenue

The average revenue per unit of electricity sold in the year was 1.176d. This was 4% above the corresponding average for 1947-48, but only 12.6% above the 1938-39 figure. The latter increase, the report states, was well below the corresponding increases in coal and in most other commodity prices, in general wage rates, and in the general cost of living. War and post-war restrictions on display and shop window lighting have meant a loss of an appreciable volume of sales at comparatively high rates. After vesting day the industry was faced with the fact that the budgetary estimates of many of the former undertakings showed actual or prospective revenue deficits, amounting to some £7 mill. for 1948-49. 'This legacy from the past,' says the report, 'had to be dealt with by immediate increases of non-industrial charges in those districts where serious deficits were likely.' The small increase over 1947-48 was mainly due, therefore, to the price adjustments for supplies to domestic and commercial consumers which were necessary to safeguard the financial position of the industry. For lighting, heating, and cooking only, which include all ordinary domestic and commercial uses of electricity, the average revenue per unit was 1.445d. This, for the reasons given above, was 4% over the 1947-48 average; but it was 9% below the average of 1938-39. The class of domestic consumers thus paid a substantially lower average price per unit of electricity in 1948-49 than before the war.

Hawick Exhibition

Sir **Andrew Clow,** speaking at the opening in Hawick on January 17 of an exhibition of modern gas and factory canteen equipment, said that they owed the exhibition both to the vigour of Mr. Robert Cowie, the Manager, and his staff, and to the enterprise shown by leaders of industry in Hawick. The Scottish Gas Board were anxious to do all they could for industry, but they were also particularly desirous of granting comfort to the homes. In the last 10 years the consumption of gas in Hawick had about doubled and, of the increase, nearly 90% was due to increased domestic use. But the board wanted to ensure that the increased demand should be accompanied by a fully efficient supply, and had accordingly decided to embark on a development scheme for gas in the town which was estimated to cost £35,000. The first section of the work, costing £19,000, was intended to be started at once.

Hire Purchase and Uniform Prices

Matters of Concern for Eastern Consultative Council

THE third meeting of the Eastern Gas Consultative Council was held at Gas Industry House on January 12, under the Chairmanship of Councillor R. Turner (Bedford). The resignation of Alderman T. H. Simmons, J.P. (Watford), on account of pressure of public work, was announced, and the Chairman reported that he had received a letter from the Minister of Fuel and Power stating that he had asked the Association of Municipal Corporations to nominate another member in place of Alderman Simmons. The Chairman also informed the Council that all Chambers of Trade in the area had been informed of the appointment and functions of the consultative council.

Joint Meter Reading

Two matters which had been considered at the previous meeting of the council, as reported in the *Journal* of November 23, p. 468, were again discussed. The first, a suggestion which had been made by Dr. Stephen Taylor, M.P. for Barnet, for electricity and gas meters to be read by the same men, had been forwarded to the Chairman of the Eastern Electricity Consultative Council. A reply had been received to the effect that in the past local authorities owning both electricity and gas undertakings had found the results of such an experiment not entirely satisfactory. There was no saving in manpower, most authorities had experienced a reduced efficiency in the service to the consumer, and the scheme had been dropped. The council agreed to accept this opinion as final. The second problem was the extra charge made to prepayment consumers. The **Chairman** said that the board regarded this complaint as a matter of importance, and a full consideration of it was promised.

Not a Parochial Problem

Two letters had been received from the Halesworth Urban District Council, together with another letter from the Halesworth and District Chamber of Commerce, regarding the present charge for gas in that area. The first letter requested a uniform charge for the area and immediate action to reduce the price in Halesworth. The Chairman said that the board had given a great deal of attention to this question, and had replied that all divisional managers in the area had been asked to consider schemes for the linking up of smaller undertakings to improve efficiency and reduce both costs and price of gas. The establishment of any particular scheme of integration would, however, be dependent on the supply of materials and its relevant importance. The board were inclined very much towards the establishment of a uniform price, but this was a long-term policy. This reply had been followed by the second letter from the Halesworth council, which asked that the larger undertakings should help in equalising the cost throughout the area by making a uniform charge. The Chairman said that he had gone to some trouble to estimate the effect of such a uniform tariff if instituted in the Norwich Division. The effect, he said, would be to impose on industry and commerce in the larger towns such as Norwich an increase of approximately 3d. per therm. Members of the council agreed that in principle a uniform price was both desirable and should be worked for. Their feelings were best expressed by Alderman **W. Bird,** M.B.E., J.P. (St. Albans), who said that it was no parochial matter, but one of national concern. Mr. **S. G. Kemp** (Norwich) suggested that the council's duty was to watch any increase in price most carefully, and Alderman **F. H. Stone** (Great Yarmouth) reminded members that an increase in price in such areas as Norwich might cut down consumption and produce an over-all increase in the uniform price.

Another letter had been received from the rural district council of Hatfield and related to the fact that it was no longer the policy of the Eastern Gas Board in the Tottenham Division to supply cookers on rental terms. The local authority viewed this as a matter of quite serious concern since new houses had been built with facilities for both electric and gas appliances. If the authority had to purchase cooking apparatus for these it would add to the cost of the houses at a time when they were being urged to keep it as low as possible. The letter had been referred to the board, who had replied that the Tottenham Division did not in fact let out cookers on simple hire, but the Division had no record of any enquiries from the architect of the Hatfield council. The architect must have referred to the Watford Division, but here they did have simple hire arrangements.

Freedom of Choice

The Chairman said that he had himself written to Hatfield expressing his own personal opinion in the matter. This was that it was not desirable for the local authority to purchase the cookers for installation as the principle of freedom of choice of the tenant could not be maintained. He had suggested that a simple system of hire purchase over a period of 10 years could make cookers available to the tenant at no greater cost than simple hire. The board, the Chairman added, had informed him that a hire purchase scheme could be agreed upon covering a period of three or five years. In his opinion the cost of a five-year hire purchase agreement, which would be approximately 1s. 10d. a week, would be too much for the average tenant of a council house, and he felt that a 10-year scheme was necessary. The council was of the opinion that neither simple hire nor direct purchase by the local authority was desirable, and agreed with the Chairman that the board should be asked to consider a 10-year hire purchase scheme.

Miss **M. L. Keith** (King's Lynn), in a letter read in her absence by the Chairman, asked the council to recommend to the board the purchase of houses for gas fitters as a measure to overcome the shortage of skilled maintenance of appliances in the area. She felt that local authorities should also be approached to grant building licences for this purpose. The Chairman said that he would bring this to the notice of the board.

The **Chairman** reported that the Minister of Fuel and Power had approved of the draft scheme for the establishment of divisional committees for the five divisions of the Eastern area.

Wales Gas Grids

Speaking on Welsh industrial opportunities in 1950, at a luncheon of the Publicity Club, in Cardiff, Mr. **T. Mervyn Jones,** Chairman of the Wales Gas Board, viewed the prospects of his own particular industry.

In 1950, he said, they would see the completion of the first stage of the western gas grid based on Margam and the start of work on the even larger eastern grid to serve Monmouthshire and East Glamorgan.

He expressed a hope that 1950 would see the getting together of industries producing potential fuels with industries potentially consuming them. Mr. Jones specially referred to coke oven gas now or shortly to be produced at Coal Board and Steel Company coke ovens, and tail gas from the National Oil Refineries at Llandarcy.

'The Wales Gas Board here and now offers its services as broker—and I hope an honest one—between both sides, for that in our view is our proper function in this traditionally vexed problem,' he went on. Some of their most valued industries had proceeded only thanks to economical coke oven gas supplies. All their industries in 1950 could benefit immeasurably by its increase.

Finally, they should conserve fuel and all coal by-products. When would they stop the profligacy of letting potentially invaluable chemicals foul chimneys and atmosphere, he asked. The economical carbonising of coal could only be done in modern gas producing plant and to a lesser extent in an electricity generating station. The brightest industrial prospect for Wales would arise when there was total redundancy in the chimney sweeping profession.

A Recovery in the output of coal was recorded last week following the falling off as a result of both the Christmas and New Year holidays. Total production amounted to 4,462,900 tons, compared with 3,715,000 tons in the previous week. In the week ended January 7 the total of workers increased by 300 to 709,200, but the number of workers at the face fell by 400 to 293,600. This was the first week since the beginning of the war in which workers were free to leave the industry. The amount of gas available last week increased by 17.3 mill. cu.ft. to 11,310 mill. cu.ft.; electricity supplies dropped by 200,000 units to 1,025.3 mill. units in the same period.

Nordac, Ltd., Chemical Engineers, are moving on February 1 from Dukes Road, Western Avenue, W.3, to Cowley Mill Road, Uxbridge, Middlesex (Telephone: Uxbridge 5131).

THE EFFLUENTS DISPOSAL PROBLEM*

By E. H. M. BADGER, B.A., F.R.I.C,
Chemist, North Thames Gas Board

THE concentration of a specific substance having a toxic effect can usually be measured by means of an appropriate chemical test. There is, however, no completely satisfactory method of assessing the degree of pollution that may result from the lowering of the dissolved oxygen in the water into which an effluent has been discharged. The Royal Commission on Sewage Disposal favoured a test in which the diminution in the dissolved oxygen content is directly measured. This test has become known as the Biochemical Oxygen Demand (B.O.D.). The water suspected of being polluted is added in appropriate proportion to a well-oxygenated water, and the dissolved oxygen content of a portion of the mixture is determined immediately. The rest is left in stoppered bottles at a constant temperature for five days and the dissolved oxygen measured again. The oxygen taken out of the water by the polluting matter is expressed as grams per 100,000 g. of effluent and is called the B.O.D. value.

This test comes very near to the actual conditions that arise when an effluent is discharged into water. But the B.O.D. value does not necessarily give the total amount of oxygen that will be eventually taken up. Thus, McGowan found that a filtered sewage absorbed 38 parts of oxygen per 100,000 in five days, and 101 parts in four months. He thought that the biochemical oxidation of sewage would go on for at least two months, but other workers have found complete oxidation in 20 days and 70% oxidation in five days. Since experience has shown that this test is of value for testing the effluent from a sewage works, it seems likely that as a general rule some fairly constant proportion of complete oxidation takes place in five days.

The B.O.D. test is obviously most suitable for testing the purity of an effluent entering a river, lake, &c. It should be applied with caution to trade effluents entering a sewer for treatment at the sewage works. These may contain substances that inhibit bacterial action for long periods. Also, substances like thiocyanate, which require the presence of a special bacterium for their oxidation might remain unchanged during the period of test.

The Royal Commission of Sewage Disposal recommended that there should be a general standard for the discharge of effluent from sewage works. It was suggested that the suspended solids should not exceed 3 parts per 100,000, and that the B.O.D. (five days) should not exceed 2 parts per 100,000. The object of such a standard was to ensure that no river or stream, after the effluent had been added, should have a B.O.D. exceeding 0.4 parts per 100,000. The volume and purity of the water into which the effluent is being discharged must obviously be taken into account, and this is probably the reason why this general standard has never been legalised, though it remains as a guide and is often quoted.

An alternative method for estimating the amount of oxygen that will be taken up by the polluting matter in an effluent is to make use of a chemical oxidising agent. The most favoured test on these lines is one in which a suitable amount of effluent is added to N/80 potassium permanganate solution under standard conditions of dilution and kept for 4 hr. at 80° F. The amount of oxygen lost by the permanganate is measured and is expressed as grams of oxygen per 100,000 g. of effluent. This figure is usually called the oxygen absorption (O/A). It is comparable with, but by no means necessarily the same as, the B.O.D. value. It gives a result in a much shorter time than the B.O.D. test and is more suitable for strong effluents, but has the objection that oxidation depends on the particular constituents present. Thus, the carbonaceous matter in domestic sewage is only oxidised to the extent of some 15%, and the ammonia is not oxidised at all. Allowance has to be made for the efficiency of oxidation in estimating from this purely chemical test the amount of oxygen that would be taken up at the sewage works by biochemical action. For domestic sewages the so-called 'McGowan strength' is often calculated for this purpose. The O/A is multiplied by 6.5, to allow for the fact that the oxidation of the carbonaceous matter is only 15% of completion, and the ammoniacal nitrogen by 4.5, which corresponds to the amount of oxygen to form nitrate from ammonia. It would, however, be quite wrong to apply the McGowan formula to a gas liquor, because the degree of oxidation of the constituents of a gas liquor in the permanganate test is very much greater than for those in a domestic sewage.

The comparatively high degree of oxidation of gas liquors in the permanganate test has been recognised by the Institute of Sewage Purification in a recent memorandum. The memorandum suggests that the oxygen absorbed in the 4 hr. test should be multiplied by 1.4. This corresponds to an assumed efficiency of oxidation of about 70%. Nothing is said in the memorandum about the effect of ammonia, but in a recent agreement for the discharge of spent gas liquor into a sewer the oxygen absorbed due to biochemical oxidation of ammonia at the sewage works is assumed to be 2.25 times the weight of ammoniacal nitrogen. This is half the theoretical amount for oxidation to nitrate, and is apparently based on the fact that in the activated-sludge process the oxidation of ammonia is not complete.

From the foregoing discussion it is clear that none of the present methods of measuring pollution is really satisfactory. Stronger oxidising agents have been proposed, such as potassium bichromate at 100° C., or ceric sulphate, but so far thay have not found general acceptance.

One of the first recommendations of the Liquor Effluents Research Committee for the improvement of the quality of ammoniacal liquor was that the tar should be separated from the gas as early as possible in the condensing system, and that liquor should not be stored in contact with tar. The electrostatic precipitator was found to be the most efficient means of removing tar fog, and the effect of its use on the composition of the liquor at Hinckley is given.

TABLE 1.—*Effect of an Electrostatic Precipitator upon the Composition of Gasworks Liquor at Hinckley*

	Without tar precipitator	With tar precipitator
Monohydric phenols (as phenol) (g. per 100 ml.)...	0.403	0.731
Polyhydric phenols (as catechol) (g. per 199 ml.)...	0.184	0.022
Total oxygen absorption (4 hr., 80° F.) (parts per 100,000)	1,191	1,450
'Difference figure' (parts per 100,000)	408	113

The precipitator was effective in causing a considerable reduction in the polyhydric phenols, but the liquor as a whole showed an increased oxygen absorption. This was due to an increase in the concentration of monohydric phenols, because all the phenol remaining in the gas after removal had to go into the liquor, whereas previously it was divided between liquor and tar. The reverse effect of decreasing the monohydric phenols and increasing the polyhydric was demonstrated by shaking liquor with tar.

TABLE 2.—*The Effect upon the Composition of Coal Gas Liquor of Shaking the Liquor with Tar*

	Original liquor	Liquor, after shaking with tar
Monohydric phenols (as phenol) (g. per 100 ml.)...	0.742	0.378
Polyhydric phenols (as catechol) (g. per 100 ml.)...	0.040	0.274

It has been stated that some of the polyhydric phenols (though not catechol itself) are difficult to oxidise biochemically. Their reduction decreases the colour of the mixture of sewage and gas liquor and, probably, also the colour of the effluent from the sewage works. Monohydric phenols are easily oxidised in admixture with sewage, and therefore the increase in the total oxygen absorbed from permanganate, caused by the early separation of tar, would not be very important. The danger of judging the quality of a liquor purely by its oxygen absorption is well brought out here, because a treatment which has produced a liquor easier to oxidise biochemically has resulted in an increased oxygen absorption.

* Abstract of a paper to the Institution of Gas Engineers. (Communication No. 360, at the research meeting, 1949.)

The improvement in the quality of liquor discharged to the sewers resulting from carrying out the recommendations of the Liquor Effluents and Ammonia Sub-Committee have been described by A. B. Britton. In 1931, a crude liquor of the following composition was being discharged to the sewers:

	g. per 100 ml.
Free ammonia	1.032
Fixed ammonia	1.09
Sulphide (H_2S)	0.137
Cyanide (HCN)	0.086
Thiocyanate (CNS)	1.08
Thiosulphate (S)	0.026
Monohydric phenols (as C_6H_5 OH)	0.377
Polyhydric phenols (as catechol)	0.318
Oxygen absorption: 4 hr., 27° C.	
	Parts per 100,000
Total	2,477
Due to sulphide	170
Due to phenols	673
Due to thiocyanate	894
Due to thiosulphate	22
Difference	718

This was found to be a very difficult liquor to deal with, and only an amount equivalent to 0.1% (400 gal. per day) of the sewage flow could be accepted. The liquor contained free ammonia and sulphide, the thiocyanate was extremely high, and the polyhydric phenols also were high. Consequently, the bulk of the liquor was transported to a chemical works. The steps taken to improve the quality of the liquor were as follows:

(1) An electrostatic detarrer was installed to remove tar fog at 160° to 170° F., and the liquid subsequently condensed was not allowed to come in contact with tar.
(2) Air was admitted at the purifiers instead of at inlet exhauster.
(3) An old sulphate plant was converted into a concentrating plant, so that the liquor could be distilled.
(4) The flow of liquor was maintained at a constant fraction of the total sewage flow.

As a result of these changes, the liquor was sufficiently improved for the whole of it to be accepted into the sewers. Mr. Britton has reported the following composition of the liquor now entering the sewer:

	g. per 100 ml.
Free ammonia	0.02
Fixed ammonia	0.02
Sulphide	Nil
Thiocyanate	0.026
Thiosulphate	0.006
Monohydric phenols	0.450
Polyhydric phenols	0.024
Oxygen absorption: 4 hr., 27° C.	
	Parts per 100,000
Total	970
Due to phenols	800
Due to thiocyanate	22
Due to thiosulphate	5
Difference	143

This is an excellent example of the improvements that can be effected without making any radical changes in carbonisation practice.

Dephenolation

It is clear that a still further improvement in the oxygen absorption of the liquor could be effected if the monohydric phenols were removed. But very careful consideration is required to decide whether this is worthwhile. The work of the Liquor Effluents and Ammonia Sub-Committee has shown that phenol is very easily oxidised in admixture with sewage, and the Sub-Committee came to the conclusion that 'the removal of phenol from gasworks liquors is of very little, if any, advantage so far as the purification of the liquors in admixture with sewage is concerned. But the Sub-Committee also points out that there is a distinction to be drawn between discharge into sewers and discharge into a waterway. Although phenol is very easily oxidised at a sewage works, it is particularly toxic to fish. Thus, 0.6 to 0.7 parts per 100,000 of phenol have been found to be toxic to trout, whereas 10 parts per 100,000 of ammonium thiocyanate were not toxic in 1 hr. Therefore, when gas liquor is discharged direct into a waterway, as is often the case in Germany, the removal of phenol may well effect a considerable improvement. A parallel case in this country is the discharge of dephenolated liquor from the Partington gasworks into the Manchester Ship Canal.

Other circumstances may arise in which it is right to dephenolate the liquor. The sewage authorities may insist that the oxygen absorption should be as low as possible, perhaps because of a relatively large volume of gas liquor to be discharged; or the basis of an authority's charge be such that it pays to dephenolate, taking into account the value of the phenols recovered.

Tar-Oil Extraction

The solvent extraction process in use at Beckton has been described by D. G. Murdoch and M. Cuckney. The solvents described above were considered and also those available from the tar-distillation plant at Beckton. Tricresyl phosphate and phenosolvan were rejected, as they were costly and not readily available. The losses from benzole were known to be high, and it was found that it was not as good a solvent as a light creosote oil, which was also better than crude heavy naphtha. Heavy creosote was too difficult to separate. It was finally decided to use a light creosote oil in a Holly-Mott washer.

The gas liquor is preheated to 20° to 25° C. and then passed through a coke tar-filter. The washing plant consists of the following 10 pairs of mixers and separators:

Stage No.	
1	Charged wash oil and water.
2, 3, 4	Wash oil and revived soda.
5-9	Gas liquor and wash oil.
10	Gas liquor detarring by oil in closed circuit.

The plant will treat up to 15,000 gal. of crude liquor per hr. The oil rate is usually half the liquor rate. Ninety to 93% of the monohydric phenols are removed, and the oxygen absorption of the liquor is reduced from 450 to 550 to 150 to 250 parts per 100,000. The partition factor of the original oil for phenols was originally 8.7, but this dropped to 2.85 after four months' use, owing to the removal of the basic constituents. It was shown that the partition factor could be greatly increased by the addition of small amounts of pyridine, quinoline and isoquinoline, but aniline had little effect. The partition factor of the oil in circulation is maintained at 4 to 5 by the regular addition of small quantities of base-containing oils derived from various ancillary processes.

If a still more basic solvent were used, it should be possible to remove a substantial fraction of the polyhydric phenols as well. But such a process would probably be done best in two stages, because from the point of view of the sale of the product it is undesirable to have the monohydric phenols contaminated with dihydric phenols. T. Nicklin has considered the removal of monohydric phenols by benzole and of dihydric phenols by phenosolvan.

The operating costs of the Beckton dephenolating plant for the year 1948 were as follows:

TABLE 3.—*Operating Costs for Treating 95.555 mill. gal. of Gasworks Liquor at Beckton Products Works*

	Total cost £	Per mill. gall. £
Wash oil	2,072	21.68
Other materials used	1,008	10.54
Plant wages	5,587	58.47
Maintaining plant	1,577	16.51
Power, including steam	6,057	63.40
Miscellaneous	120	1.26
	16,421	171.86

On the credit side is the revenue from the sale of the phenols and the saving in charges for treatment at the sewage works. The Beckton plant was built before the great increase in capital costs, and the result has been that the process has been profitable. If such

a plant were being constructed at the present time, difficulties might arise over the steel allocation. The quantity of steel required might be reduced by the replacement of the present type of mixer by a system involving the feeding of the two liquids into gear pumps, as has been done in the phenosolvan process. Experiments on these lines have been carried out and have been successful on the small scale.

Methods of Disposing of Liquor

The foregoing discussion should have made it clear that the discharge of gasworks liquor into a natural inland waterway should not be allowed without a considerable degree of purification. Even discharge to tidal waters needs care in avoiding local concentrations of toxic material. The work of the last 20 years has established that the best method of purification, at present, is to discharge from the gasworks as good a liquor as is reasonably possible into the sewers, so that the final purification is one of biochemical oxidation at the sewage works. This is generally agreed by both gas and sewage authorities.

The effect of adding gas liquor to sewage has been investigated in some detail by the Liquor Effluents and Ammonia Sub-Committee. The results of large-scale tests on percolating filters at the sewage works at Leamington are summarised below. The liquor was from vertical retorts, both crude and spent liquor being used. The oxygen absorptions from permanganate were 1,869 and 1,019, respectively.

TABLE 4.—*Results of Large-scale Tests on Percolating Filters at the Leamington Sewage Works*

Gas liquor added	Inlet filters	Outlet filters	
	O/A	O/A	B.O.D.
None	3.45	0.79	0.81
0.25% crude liquor ...	4.59	0.98	1.18
0.25% spent liquor ...	4.46	0.90	0.95
None	3.43	0.78	1.09
0.5% crude liquor ...	9.30	1.21	2.96
0.5% spent liquor ...	6.93	1.08	1.67

The tests on the effluents from the final filters showed some increase when gas liquor was being treated, but were satisfactory except for the B.O.D. when 0.5% crude ammoniacal liquor had been added. This was shown to be due to incomplete oxidation of the ammonia. These and other results made it clear that the amount of ammonia discharged to the sewers should be as low as possible.

Tests on the effect of the individual constituents of gas liquors on the effluent from sewage filters were also made. These showed that phenol was easily oxidised, and so was catechol, but that some of the other polyhydric phenols were not. Certain of these colour-producing bodies can pass through the filters and cause an increase in the O/A of the effluent, but the effect on the B.O.D. is small—*i.e.*, they are more easily oxidised chemically than biochemically. Thiocyanate is not oxidised until a certain bacterial flora has been built up on the filters. This is one of the reasons why gas liquor should be discharged to the sewers regularly and not in flushes.

All the evidence goes to show that a spent liquor of reasonable quality can be satisfactorily oxidised when mixed with sewage to the extent of about 0.5% of the sewage flow. The quantity of crude liquor that can be accepted will be less than this owing to the extra load thrown by the ammonia and sulphide. The amount of spent or crude liquor that can be tolerated in a particular case will, of course, depend on the quality of the liquor and the capacity of the sewage works.

The Public Health (Drainage of Trade Premises) Act, 1937, gives the trader the right to discharge his effluent into the sewers, and he may exercise this right without any consent so far as he may be permitted by the bye-laws made under the Act, but otherwise he must obtain the consent of the appropriate local authority. The trader may be called upon to pay a fair sum for the treatment of his effluent, though this is without prejudice to any 'prescriptive rights' he may have obtained. Owing to the complicated nature of gas liquor and the different effects the various components have on sewage purification, the subject of fair payment for treatment is a particularly difficult one. A working rule for payment for trade effluents which seems to be accepted by many sewage authorities is that of the 'Townend formula.' At the time it was put forward the basis of this formula was a charge of 25s. per ton of oxygen absorbed at the sewage works, plus 30s. per ton of suspended solids, and 1d. per 1,000 gal. for pumping. On such a basis, a gasworks which installed an electrostatic precipitator in order to reduce the higher tar acids would have to pay more because of the increase in O/A due to the greatly increased quantity of monohydric phenols in the liquor. Yet it is agreed by both sides that monohydric phenols are particularly easy to oxidise. On the other hand it may be very difficult to decide on any more just basis of charge for the various constituents and also on the charges between one trade waste and another.

In any case the smaller concerns are unlikely to want agreements of a kind which would involve regular chemical analyses of a rather intricate nature. For small discharges it is probably best to specify limiting values for the properties of the liquor, and to pay purely on a volume basis.

An agreement of this type was suggested, by the Ministry of Health, as a result of an appeal under the Public Health (Drainage of Trade Premises) Act, 1937, by the Ascot District Gas and Electricity Company against the refusal of the Windsor Rural District Council to allow a discharge of spent gas liquor into the sewers. The Council based its refusal on the grounds that spent gas liquor upset the process of sludge digestion (not to be confused with the activated sludge process), and the appeal by the gas company was the first of its kind under the Act.

The Ministry of Health decided that the spent liquor should be admitted under the following conditions:

(1) The volume discharged in any one day of 24 hr. shall not exceed 2,200 gal.
(2) The volume discharged in any 1 hr. from 6 a.m. to 10 p.m. shall not exceed 120 gal.
(3) The volume discharged in any 1 hr. from 10 p.m. to 6 a.m. shall not exceed 60 gal.
(4) The composition of the gas liquor effluent at the point of measurement by the discharge recorder shall be subject to the following limitations:
  (*a*) Oxygen absorbed from N/80 acid potassium permanganate in 4 hr. at 26.7° C. shall not exceed 1,200 parts per 100,000 by weight.
  (*b*) Free ammonia (calculated as NH_3) determined by simple boiling, without addition of alkali, and distillation into a standard solution of acid shall not exceed 40 parts per 100,000.
  (*c*) Sulphide (calculated as S) shall not exceed 10 parts per 100,000.
  (*d*) Suspended solid matter shall not exceed 6 parts per 100,000.
  (*e*) The *p*H value shall not be less than 6 nor more than 10.
  (*f*) Tar and tar oils not dissolved in the aqueous liquid shall not exceed 6 parts per 100,000.
(5) Temperature of the gas liquor at the point of discharge shall not be higher than 110° F.
(6) The Ascot District Gas and Electricity Company shall pay to the Council 2s. 6d. per 1,000 gal. of gas liquor effluent discharged to the sewers.
(7) The conditions suggested in No. 8 of the model bye-laws of the Ministry of Health for the reception of trade wastes into sewers.

This type of agreement involves control and measurement of the discharge, but only occasional analysis to ensure that the specifications are adhered to.

The suggestion of the council that spent gas liquor could upset the process of sludge digestion, which involves the anaerobic fermentation of the solid matter of sewage in deep tanks, had not been made previously. Further investigation at the sewage works produced no evidence that the liquor had any effect on the process.

The charge of 2s. 6d. per 1,000 gal. laid down by the Ministry of Health was higher than that of some other agreements between gas and sewage undertakings. In the discussion to the paper, by A. Sciver and E. H. M. Badger, describing the work at Ascot, Mr. W. T. Lockett, Chief Chemist at Mogden sewage works, wrote in 1943: 'Information gained from several sources indicates that a charge of 2s. 6d. per 1,000 gal. for the treatment of gas liquor at a sewage purification works is by no means excessive; but, no doubt,

in some cases (*e.g.*, the case of a works operating on a larger scale), the cost of purification of liquor of the same strength as that discharged by the Ascot District Gas Company would be in the region of 2s. per 1,000 gal., or possibly less.'

There seems little doubt that at present the best way to dispose of gas liquor should be distillation followed by a carefully regulated discharge to the sewer. As was so well shown at Hinckley, care should be taken to keep the thiocyanate as low as possible, and also the polyhydric phenols, though an electrostatic precipitator would probably not be necessary in a horizontal retort stream.

But, with increased centralisation of gasmaking capacity, the flow of liquor to be discharged may well exceed 0.5% of the sewage flow. In this situation some further action may be necessary.

It has been suggested that it might well be that sewage disposal works would have to be organised in larger centralised units in order adequately to deal with trade waste loads which otherwise would be insufficiently balanced by domestic sewage at small works. Undoubtedly, a large sewage works could deal with a problem which would put a small works right out of action.

Whatever the decisions affecting policy that might be taken, it is unlikely that the Ministry of Health would force a local authority to accept a quantity of trade waste which was greatly in excess of its present purification capacity. Some solution, other than the normal one, would have to be found, even if it were only temporary. If dephenolation were carried out, it might be possible to dispose of a larger volume of liquor than otherwise, though, as has often been stressed, it is more important to remove the polyhydric than the monohydric phenols.

Biochemical oxidation on the gasworks itself was tried at Coventry. The process took up much space, and the effluent was never good enough to discharge to a stream, so that the oxidation of the more resistant substances still had to be carried out at the sewage works.

T. Nicklin has described a scheme for disposing of liquor without discharging any effluent to the foul sewers. The crude final liquor is treated in a benzole washing plant, whereby 80 to 95% of the monohydric phenols are removed. The washed liquor is then distilled in a concentrating plant, and the spent liquor concentrated in a triple-effect vacuum evaporator, whereby a liquor containing 20% NH_4Cl is produced. This liquor is then cooled and washed in a phenosolvan plant to remove the polyhydric phenols. The liquor is then further evaporated in a vacuum crystalliser, so that solid ammonium chloride is obtained.

The condensates from the vacuum evaporator and vacuum contain some evaporated phenol. Mr. Nicklin suggested that this could be disposed of by (*a*) coke quenching, (*b*) as make up water to a water cooling tower, (*c*) on producer fires, and (*d*) to surface water drains or boiler feed after removal of phenol by active carbon. The mother liquor from the ammonium chloride crystalliser would build up in thiocyanate and thiosulphate. Portions of the mother liquor would be disposed of from time to time, by road tank, as thiocyanate and thiosulphate concentrates, for which a market might be found.

One may picture the overall effect of this scheme, from the point of view of the bulk of liquid to be disposed of, as the transformation of crude ammoniacal liquor into a roughly equal volume of condensate from the vacuum evaporators, which is stated to consist merely of a 0.07% solution of phenol. Such a liquid should certainly be less objectionable to dispose of by evaporation than crude or spent liquor. It was shown at Hinckley that 16 gal. per ton of spent liquor could be evaporated on the bars of the producers without extra cost in fuel, but evaporation schemes are usually not very much favoured, because of corrosion troubles and the possibility of aerial pollution. Mr. Nicklin also suggests the use of carbon filters to permit the discharge to surface water drains or to the boiler feed-water system. Since the higher tar acids would be absent, the premature fouling of the carbon would not take place, and the use of carbon for this purpose should be practicable.

In Mr. Nicklin's process, the thiocyanate and thiosulphate would be concentrated in the mother liquor of the vacuum crystalliser. The facts that the concentrations of these inorganic constituents in effluents are comparable with the concentrations of the solids present in normal waters, and that ion-exchange processes have been successfully applied to water treatment, offered the prospect that it might be possible to effect the economic removal of these constituents by a similar method. Following small-scale work, experiments on ion-exchange methods, sponsored by the Permutit Company, Stewarts and Lloyds, and the Woodall-Duckham Company, are in progress on a pilot-plant scale at a large coke oven plant. Liquor, after removal of free ammonia, is filtered and passed through a bed of a basic anion-removing agent under such conditions that the thiocyanate and thiosulphate are taken up by the agent. From time to time, the flow of liquor is interrupted and an alkaline solution is passed through the bed to remove the thiocyanate and thiosulphate, which are thus concentrated into a very small bulk of liquid, the disposal of which, after recovery of the alkali, presents no great problem. The process greatly improves the colour of the liquor.

This experimental work foreshadows the possibility that a combined process of dephenolation and ion exchange may give rise to a pale-coloured effluent having a very low O/A value. The work is at too early a stage to enable any forecast of the cost of the process to be made. It will be necessary, in particular, to study the behaviour of the medium over a protracted period and to evaluate the operating conditions which give the best efficiency.

MIDLAND ASSOCIATION DISCUSSION

Discussion of Mr. Badger's paper was continued at a meeting of the Midland Association of Gas Engineers and Managers at the Queen's Hotel, Birmingham, on January 19, under the Presidency of Mr. S. J. Sadler.

Mr. **Badger,** in presenting a summary of the paper, said there were three points he would like discussed: (1) Was it agreed that the normal method of liquor disposal should be distillation followed by a controlled discharge to the sewers? (2) In what circumstances was it correct to dephenolate gas liquor? (3) What was the cost to the sewage works of the treatment of gas liquor?

The work of Dr. Key with the Liquor Effluents and Ammonia Committee of the Institution of Gas Engineers had made it clear that it was much easier for a sewage works to deal with spent gas liquor than with crude ammoniacal liquor. The same view was expressed in the memorandum issued by the Institute of Sewage Purification on April 30, 1949. The recommendations of the Institution of Gas Engineers had been successfully carried out at Hinckley, as was well known. In his own paper he had shown how distillation reduced the total oxygen needed for complete biochemical oxidation of a liquor from 1356.5 lb./hr. to 525.4 lb./hr. and that this was still further reduced to 201.3 lb./hr. by excluding the circulating liquor.

However, he was aware that crude ammoniacal liquor was being discharged to the sewers in many places. The results of such a discharge on the working of a sewage purification works were described to the Institute of Sewage Purification by Mr. A. J. Clifford last November[1]. He would be interested to know whether this discharge of crude ammoniacal liquor was regarded as a temporary or as a permanent solution to the disposal problem.

As regards dephenolation, he did not think they had yet reached the stage when dephenolating plants were put in as a matter of course. It would seem that at present dephenolation was carried out either because the situation at the sewage works made it imperative to reduce the oxygen absorption below that of untreated spent liquor or because the type of agreement with the sewage authorities made it profitable for the gasworks to do so. Dephenolation was also an essential part of the still more elaborate process of producing an effluent fit to discharge direct to a stream. A recent paper by J. J. Priestley to the Scottish Junior Gas Association had provided information about plants for this purpose which are at present under construction[2].

In the account of dephenolation in his own paper he should have mentioned the B.I.O.S. Miscellaneous Report No. 68, in which Dr. W. H. Oppelt discussed German experience in the dephenolation of waste liquors[3]. In some of the plants he described loss of the solvent was caused by the formation of emulsions. Emulsification might be aggravated by the presence of dust and tar. He listed the following requirements for a good solvent: Good solubility for phenol; low cost so that losses do not influence too much the economy of the process; the solvent should be manufactured at the plant itself, so that losses can be easily replaced and that fresh solvent is always available; the solvent should be almost insoluble in

the liquor ; the solvent should have no emulsifying tendencies ; the solvent should not be decomposed by alkali or during the distillation process ; the solvent should have a low vapour pressure ; the specific gravity of the solvent should differ sufficiently from that of the liquor so that separation by gravity takes place ; the phenol should be easily recoverable from the solvent.

These requirements seemed very sound, but it was not to be expected that any particular solvent would satisfy them all to the same extent. In the North Thames Gas Board they had preferred to use a tar-oil solvent that was one of their own products and which had a partition coefficient of about 5 rather than to buy a solvent with a higher partition coefficient. They agreed with Dr. Oppelt's statement that the partition coefficient could be increased by the addition of pyridine or quinoline, but that aniline had little effect.

As regards the cost of purifying gas liquor at the sewage works there did not yet seem to be any agreed figure. In his report for 1948 the Director of Water Pollution Research described experiments carried on at Coventry on the addition of spent gas liquor to domestic sewage[4]. Parallel experiments were being conducted on two similar filters treating domestic sewage with and without the addition of gas liquor. Other workers[5] had given some estimates of the amount of extra capacity required at the sewage works to produce an effluent of the same quality from sewage containing gas liquor as was produced from sewage with no gas liquor, but this had not yet been related to the composition and concentration of the gas liquor and of the method of working the sewage plant.

Future Legislation

Mr. **J. Hurley,** B.SC., F.R.I.C. (Tettenhall, Wolverhampton), emphasised the value of joint meetings of gas engineers and sewage purification engineers and hoped that what had been done in the Midlands would be extended to other parts of the country. Some sewage works managers—usually those who knew least about the problems involved—had been difficult to get on with. On the other hand, some gas engineers had been just as bad, in that so long as their effluent was not so thick as tar they could not imagine that it would cause trouble anywhere. Mr. Badger's paper was an excellent and fair summary of the present position of liquor disposal, but it would take much more than a single meeting to answer the three points which he had submitted. It was unfortunate that there were no legal standards of quality for sewage effluents or for effluents discharged to streams. There was, however, much useful information in a recent Stationery Office publication on the prevention of river pollution. A committee wtih the high-sounding title of the Pollution Prevention Sub-Committee of the Central Advisory Water Committee had been set up and had proposed some important changes in the law relating to pollution, most of which were likely to be implemented. One recommendation was that the River Boards should have power to prescribe standards for streams and for particular stretches of streams, and another recommendation was a change in the law relating to the prosecution of industrial undertakings. Under existing law a river authority could prosecute a local authority, but if it desired to prosecute an industrial concern it first had to get the consent of the Ministry of Health. He agreed with the author that none of the present methods of measuring pollution was really satisfactory. Dr. Butcher, of the Ministry of Agriculture and Fisheries, who had made headway in the matter of biological standards for streams, had emphasised the importance of the discharge of a consistent effluent.

Dealing with Mr. Badger's three questions, he thought that so far as sewage works engineers were concerned it was agreed that the normal method of liquor disposal should be distillation followed by regulated discharge to the sewer. On the second question, phenol was not difficult to oxidise, and if gas liquor was to be discharged into streams it certainly ought to be dephenolated. Mr. Badger's third question raised a point on which sewage works and gasworks engineers had never been able to agree, but his own view was that at present day prices most sewage works could treat gasworks liquor for about 8s. to 8s. 6d. per 1,000 gal. It was fairly generally agreed that electrostatic detarring should be practised wherever possible. The higher tar acids were a great trouble to sewage works, not only in regard to purification but in indirect ways, causing frothing and discolouring the effluent. As methods of dephenolation improved they would find increasing numbers of gasworks carrying out dephenolation.

Dr. **R. W. Butcher** (Trent Fishery Board) said that in reading the paper he had been struck by the fact that there was too much emphasis on oxygen absorption and too little on the question of toxicity. He suggested that in the future the gas industry would have to employ biologists to help in the solution of the effluent problem. They purified their liquor to prevent pollution of rivers, and for no other reason, and pollution was almost entirely a biological problem, and not a chemical one. Some years ago Parliament passed an Act which prevented experiments on fish; it was unfortunate that such experiments were not allowed.

Mr. **A. J. Clifford,** M.INST.S.P (West Bromwich) suggested that some distinction should be drawn between 'disposal' and 'purification' of effluent. The more immediate concern of the gas engineer was the question of purification.

Strength of Liquor

Mr. **C. B. O. Jones,** F.C.S., F.INST.S.P. (City of Coventry Chemical Laboratory) said that at Coventry during recent weeks the discharge of liquor had varied from 46,000 gal. to 24,000 gal. per day—a variation which made a difference in the biological processes they had to control. It was well known that the strength of liquor was related to the coal carbonised ; he believed that in the Midlands the Cannock coal used gave a liquor around the 1,000 mark, whereas Durham coals gave a liquor of about 700. He wondered whether the nationalised coal and gas industries could get together to provide coals with lower O.A. values. He had recently caught sight of a document at a gasworks showing that the coal carbonised came from some 27 different collieries, indicating a great waste of money and labour.

Mr. **A. B. Britton** (Hinckley) said that as Chairman of the local Technical Committee he greatly appreciated Mr. Badger's visit and the presence of so many members of the Institute of Sewage Purification. They were all striving to serve the public in one direction or another, one being just as important as the other. The report on the prevention of river pollution mentioned by Mr. Hurley was indicative of the sort of legislation they were likely to get and of what the gas industry and the sewage authorities could do to help themselves. He emphasised the desirability of making the least possible liquor of the highest possible strength. Gas liquor had been a drug on the market for the past 20 odd years and they seemed to have lost the art of making a strong liquor. In his own early days—40 years ago to be precise—the strength of the liquor was just as important as the calorific value of the gas was today. They were paid for their liquor on the basis of strength. Latterly, as the liquor had become a drug on the market, there had been a tendency to produce a weaker liquor. He urged that they should make it as strong as possible so that the sewage works would have to deal with a lower volume, yet of little more toxicity. The toxic content of the liquor could be regulated to a fair degree by the way they ran their plant. For the benefit of the members of the Institute of Sewage Purification he pointed out that they could not make gas out of every type of coal; Cannock coal, for example, was not a suitable coal for gas making. While the type of coal did to some extent make some difference in the type of liquor produced the major factor was the type of plant used in carbonisation. They in the West Midlands had a predominance of continuous vertical retorts which gave a liquor very difficult to treat because of the larger proportion of higher tar acids.

Need for Further Study

On the question of dealing with the liquor, there was no reason why gas undertakings could not arrange their dosage with the sewage works manager. They in the West Midlands were the first to endeavour to get together with the Institute of Sewage Purification and the local authorities in an effort to solve their problems, problems which were common to them all and incapable of solution separately. It was hoped that some type of committee would be formed at a high level under which they might form district joint committees to co-operate in the solution of their problems. At a high level they had not advanced as quickly as some had hoped, but everything possible would be done to speed the formation of some such committee.

Mr. **C. L. Evans** (Chief Chemist, Nechells Works, Brotherton & Co., Ltd., and formerly of the Birmingham gas undertaking) suggested that they did not yet know enough about the liquors which they were trying to purify. Regarding the higher tar acids, for example, it was not known whether the bacteria were unable to oxidise the acids or whether the acids inhibited the action of the bacteria; possibly the latter was nearer the truth. A further study should be made of the higher tar acids which might bring about some amended treatment of the liquor.

Mr. H. Dixon, M.INST.S.P (Redditch) said that as a result of meetings with gas managers it had been arranged that samples should be taken at the sewage works daily, and they were carrying out in their own little laboratory certain routine analyses; at the same time corresponding analyses were being conducted in the laboratories of the West Midlands Gas Board. The results shown were very interesting and they had speeded up slightly the discharge of spent liquor into the sewers.

Mr. F. G. Brougall (Midland Tar Distillers) said it seemed to him that the economics of the various dephenolation processes had not been fully investigated. Each process had its own peculiar disadvantages. Tar distillation was a very essential part of any gasworks organisation. The tar was almost always concentrated out of all proportion to the domestic effluent available at the sewage works.

Mr. C. F. W. Rendle (Worcester and Hereford Division, West Midlands Gas Board) endorsed Mr. Britton's plea for smaller quantities of liquors of higher strength. The higher the strength of the liquor produced at their gasworks the less volume there would be to deal with.

Mr. T. F. E. Rhead (Scientific Adviser, West Midlands Gas Board) described the meeting as the most representative gathering he had yet seen concerning the effluents problem; it was good to see representatives of the River Boards, the Institute of Sewage Purification, and gas industry, and the D.S.I.R. (represented by Mr. T. G. Tomlinson) getting down to the problem. Dr. Butcher had shown that the ultimate test of their effluent was its effect on the life in the river. It was going to be impossible for some years for the gas industry to get all the plant it would like and therefore any improvements which could be made without entailing the installation of new plant were to be encouraged.

Mr. Badger, in a brief reply to the points raised in the discussion, welcomed the increased co-operation between the gas and sewage authorities. The time was past when they fought each other, and they wanted to get things on a proper basis. He had read the report on the prevention of river pollution to which Mr. Hurley had referred and had found it very interesting. He thought most people would welcome a greater measure of standardisation. The question of methods of measurement was a difficult one; it had always puzzled him that our old methods had survived for so long. It seemed to be the general opinion that it was not very advisable to put crude liquor into the sewers on account of the presence of cyanide and the consequent danger to men working in the sewers.

With regard to the form of life in rivers as a measure of pollution, one would need a laboratory test. If a river were polluted already and organisms were not living in the stretch of the river affected it would be difficult to see the effect of any particular effluent unless there was some separate test. Mr. Jones had raised an interesting point about the variations in the volume of the discharge. One often heard of a small undertaking arranging an agreement with a local authority and basing its terms on a single sample. There might conceivably be wide variations from day to day, and what was needed was statistical data. He agreed with Mr. Britton that the type of carbonising plant was more important than the variety of coal carbonised; the O.A. depended largely on the degree of decomposition achieved in carbonisation.

A vote of thanks was accorded to Mr. Badger on the proposition of Mr. **Hurley,** seconded by Mr. **Britton.**

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[1] Experimental Work on the Treatment of Gas Liquor. County Borough of West Bromwich. Paper to Midland Branch of the Institute of Sewage Purification, November 23, 1949.
[2] J. J. Priestley, Gas J. 1949, **260,** 532, 594, 659.
[3] Problems of the dephenolisation of waste liquors. W. H. Oppelt, B.I.O.S. Miscellaneous Report No. 68.
[4] Water Pollution Research 1948. D.S.I.R.
[5] J. H. Garner. J. Inst. Munic. Engineers, 1949, **75,** 784. R. Hicks (Discussion) J. Inst. Sanit. Engineers 1949, **48,** 104.

EXPERIMENTAL WORK AT WEST BROMWICH

***EDITOR'S NOTE:*—In the *Journal* of November 30 last we gave an abstract of a paper by Mr. A. J. Clifford to the Midland Branch of the Institute of Sewage Purification in which he described recent experimental work on the treatment of gas liquor at West Bromwich sewage works. The following is a report of the discussion on the paper**

MR. **C. L. EVANS** expressed on behalf of the many troubled engineers in the gas industry a tribute to Mr. Clifford for providing what appeared to be an answer to the gas engineers' prayer, the prospect of peace with the sewage works manager.

The problem of gas liquor disposal, he continued, was one that had for some time been receiving the attention of the West Midlands Gas Board. He believed that joint effort would do much to remove the difficulties and misunderstanding prevalent in the past. Much work has been done in the past on liquor disposal with sewage. Results had suggested that at a properly organised sewage works concentrations of the order of 0.25% crude or 0.5% spent liquor could be dealt with satisfactorily. They now learned that by the installation of recirculation, at a non-prohibitive cost, almost double this concentration of crude liquor was amenable to treatment.

Mr. Evans continued that this fact was of extreme importance to the gas industry today, where possible extensions to increase output had to be considered. The imposition of regulations on trade effluents in general at a time when extra production was called for, would be in itself a great strain on industry. That rivers should be watercourses and not sewers should be everyone's desire and it thus called for joint action, whatever the difficulties, to bring about improvements. The effluents from the gas industry had always been greatly suspect because of their high O.A. He would like to know the damage caused by chemical absorption of the dissolved oxygen of such effluents entering rivers, compared with the physical denudation of oxygen by the temperature rise caused by electrical power stations.

Mr. Clifford had raised the question of frothing difficulties with excess liquor concentrations and had spoken of the necessity of delivering liquor to sewage works and of not permitting direct discharge to sewers. He thought partial treatment at gasworks would reverse Mr. Clifford's views on direct discharge to sewers. It must be emphasised that transport charges for carriage of liquor to sewage works amounting to 30s. or more per 1,000 gal. superimposed on disposal charges could not be tolerated in a final scheme.

Much discussion had taken place in the West Midlands on formulæ for arriving at charges for effluent treatment. The basis used by Clifford was equitable. In the absence of reliable data on bacterial treatment of individual components of liquor, he felt that the most scientific system of accessing loadage on filter beds, O.A., had been adopted. No doubt as further scientific evidence was brought to light, further modifications of a system of charging would become necessary.

He would like to ask a few questions on theoretical considerations of recirculation. It was stated that recirculation had the effect of considerably reducing O.A. partly by dilution and partly by oxidation. Had Mr. Clifford determined O.A. in tank effluent? If high, might it not be that increased filter bed capacity was due mostly to chemical oxidation rather than benefits derived from double contact with bacterial filter. If this was so, what had been done as a temporary expedient at Rea Hall might well become an established practice at sewage works dealing with gas liquor effluents.

Mr. T. G. Tomlinson (Water Pollution Research Board), said that previous large scale experiments carried out by the Liquor Effluents and Ammonia Committee of the Institution of Gas Engineers in collaboration with managers of sewage disposal works had been of short duration, and were concerned with the treatment of mixtures of sewage and gas liquor by single filtration at low rates of flow. Mr. Clifford's experiments were the first to be carried out with high rate processes. The performance of the filter operated with recirculation of effluent at 116 gal. of settled sewage containing 0.5% of crude gas liquor per day per cube yard was remarkable.

He would like to have seen some data on the B.O.D. of the effluents produced. High rate processes which had been found successful in the treatment of sewage might not be equally successful in the treatment of waste waters which required a

certain period of biological oxidation in the filter. As an example, the oxidation of ammonia called for a certain rate of treatment and it seemed probable that many of the other constituents of gas liquor would follow a similar course.

The relative merits of different processes depended on other factors in addition to the quality of the effluent produced under optimum conditions. Experiments carried out at Minworth had shown that alternating double filtration produced better effluents, on the whole, than filtration with recirculation of effluent at the same rate. The difference was greatest during the first four months of the year because alternating double filtration maintained the filter in a better condition. In comparing different processes it was necessary to carry out the experiments for at least a year. Another reason for continuing the experiments on the treatment of gas liquor for a year was to investigate the effect of seasonal variations of temperature and variations in the volume of gas liquor produced at the gasworks.

Mr. Clifford's version of alternating double filtration was not the same as that advocated by the Water Pollution Research laboratory, since in his experiments effluents from both primary and secondary filters were settled in the same tanks.

It had been suggested, during the course of an investigation which is being carried out by the Water Pollution Research laboratory in co-operation with the Coventry sewage disposal department, that the finely divided nature of solid matter discharged from filters at the Finham works be caused by the presence of gas liquor in the sewage. Experiments now in process at Stychall, Coventry, on the treatment of sewage and a mixture of sewage and gas liquor by single filtration. The rate of treatment was on the average 60 g.y.d., although during the day the flow approaches 100 g.y.d. The sewage was purely domestic in origin and the highest concentration of spent gas liquor used so far was 0.5%. Results obtained so far showed that the presence of gas liquor had a deleterious effect on the quality of the effluent, but preliminary tests indicated little difference between the rates of settlement of humus from the two filters. The gas liquor was mixed with sewage just prior to filtration and the effluent was only slightly coloured whereas both sewage and effluent at the Finham works were often deeply coloured. It remained to be discovered whether a period of contact with sewage had any effect on the treatment of gas liquor by biological filtration other than by producing coloured substances which were resistant to treatment in the filter.

Mr. **A. B. Britton** (West Midlands Gas Board) remarked that the gas industry had a very large and formidable problem to face in the disposal of trade waste, and it would be impossible to solve without the co-operation of the members of the Institute of Sewage Purification. Realising even before vesting date the urgency of this work, the West Midlands Gas Board set up a special Advisory Panel for the business of effluent disposal. As was mentioned in the I.S.P. memorandum published a few months ago on gas liquor disposal, they also did not favour passing crude ammoniacal liquor to waste.

Mr. Britton said he was concerned that payment was being assessed on oxygen loading and he trusted that the time would come when the different constituents of gasworks liquor could be assessed from a purification point of view and charges made accordingly. He had in mind the position of an undertaking which wished to install electrostatic tar precipitation in the hot gas stream. In this process the liquor could be made practically free from higher tar acids, and it was these bodies, or some of them, which gave the greatest difficulty at the sewage works. He submitted that if the phenols in the liquor were monohydric, then purification would be a very simple matter. Unfortunately, such liquor, although free from higher tar acids, contained higher quantities of monohydric phenols, and accordingly, a higher O.A. figure, which would mean that the undertaking would pay more for liquor disposal. Such a practice would tend to dissuade an undertaking from spending capital on plant for liquor purification, which, in his opinion, was the best known method of preparing a liquor which could be readily dealt with at the sewage works.

Dr. **S. H. Jenkins** (Birmingham) noticed that the strength of the sewage and gas liquor had been compared on an O.A. basis, according to which the gas liquor absorbed 60% of the filter capacity. This appeared to imply that the same results would be obtained if the O.A. increase had been due to sewage, and he therefore asked the author if it was at all possible to increase the load of 100 lb. O.A. per filter to 250 lb. of O.A. due entirely to sewage, by adopting recirculation. The author's apportionment of cost in the rate of 40% for sewage to 60% for gas liquor argued that the filter would treat the 250 lb. of O.A. no matter what the O.A. was due to.

Dr. Jenkins asked for B.O.D. figures for the sewage, tank effluent with and without gas liquor ,and the filter effluent with and without gas liquor, and if possible for B.O.D. figures for the gas liquor determined in the presence of sewage. He wished to work out the B.O.D. loading on the filters. It was on the comparison between the O.A. loading and B.O.D. loading that Mr. O'Shaughnessy had been able to deduce that at Cheltenham ammoniacal gas liquor was about 2½ times easier to treat than sewage of comparable O.A. strength.

The question of cost of treatment of gas liquor was an important one, since it was tied up with the analytical figures and the performance of the experimental plant. He queried whether it would cost as little as 0.45d. to purify 1 lb. of O.A. at West Bromwich on the basis of the author's results. The 1,750 cubic yards of filter, plus humus tanks, would today cost about £5,250 which at 5% for capital and loan charges would be £157 per annum, or 0.69d. per lb. O.A. Power, administration, and supervision of a return effluent scheme would bring this cost up to not less than 1d.

The matters raised in the discussion and the divergent opinions regarding the value of sanitary analytical figures applied to gas liquor, prompted him to mention that the Birmingham Drainage Board had undertaken to investigate the behaviour of different constituents of gas liquor during sewage purification under controlled conditions. It was hoped that it would thereby be possible to give a lead to the gas industry as to the value of removing certain constituents before the gas liquor entered the sewers.

Mr. **S. K. Hawthorn** (West Midlands Gas Board) said the gas industry fully recognised that it had a very difficult effluent to dispose of and yet discharge to the sewers with or without prior treatment was usually the only practical solution. The problem of gas liquor disposal had become more prominent of recent years, partly on account of the provisions of the 1937 Act, partly because less liquor had been sold outside areas of gas supply, and partly because sewage works had become overloaded during the war years and since, due to inability to carry out extensions.

When the problem of liquor disposal from Swan Village gasworks arose, they approached the West Bromwich Surveyor and Mr. Clifford, who had throughout shown the most willing co-operation in helping to solve their difficulties. If the local authorities and the gas industry could co-operate nationally, as West Bromwich had with Birmingham, the difficulties would be eased quite soon. Mr. Clifford had shown that substantially greater quantities of raw gas liquor could be treated by means of recirculation and they in the gas industry were doing all they could to improve the quality of effluent discharge. Mr. Hawthorn emphasised that the present method of sending liquor to the Rea Hall works was very expensive, as in addition to the direct charge made the board had to pay transport charges and also make the major contribution to the equipment installed at the sewage works. Their problem was to so reduce the O.A. of their effluent that all of it could be discharged to the sewers without exceeding the capacity of the sewage works to deal with it. To this end the board was installing dephenolating plant and ammonia concentrating plant. It was hoped by these means to reduce the O.A. from about 1,600 to 400.

At the new gasworks now under construction at Swan Village hot detarrers would be installed with the object of excluding to a large extent the higher tar acids from liquor, subsequently condensed. The liquor coming from the retort house would be dealt with quite separately, and it was hoped to devise means of reducing the particular toxic properties.

Mr. **J. Hurley** (Wolverhampton) remarked that a pleasing feature of the West Bromwich investigations had been the active co-operation between the gas and sewage undertakings, which he thought was typical of the general attitude towards the gas liquor problem at the present time. There had always been a good measure of collaboration between the technical men in the two professions, but there had recently been an improvement in the direction of getting their findings applied in gasworks practice.

On the question of charging for the treatment of gas liquor, he thought the West Bromwich method of ascertaining this cost contained some false assumptions. However, some of these favoured the gas industry and some the sewage undertakings. For example, the author had penalised the gas industry by assuming that a lb. of O.A. loading due to gas liquor was as expensive to move as a lb. of O.A., due to sewage. On the other hand he had been generous in charging the gas industry with only 60% of the cost of altering the sewage works to make it capable of accepting the liquor. He might well

have debited them with the whole additional capital and running costs, except for the provision of some additional humus tanks which were probably needed in any case. The speaker considered that the errors about balanced each other, and that the final answer given in the paper was as near correct as made no matter.

The author was to be commended for seeking a scientific basis for charging for the treatment of gas liquor, but a charge based on O.A. might be open to some abuse. It encouraged the gas undertakings to concentrate on such pretreatment as dephenolation, which brought about a big reduction in O.A., but was of relatively little value in most cases to the sewage works, but it offered no inducement to embark on such processes as electrostatic detarring, which helped the sewage works by diminishing the higher tar acid content of the liquor, but tended to raise the O.A. through increasing the concentration of monohydric phenols. One could hardly expect that the prospect of an increase would induce the gas industry to adopt this process with enthusiasm. However, it was much easier to criticise the O.A. method of charging than to suggest anything better. Possibly the answer might be to make the O.A. 'rebates' conditional on the higher tar acids being reduced to some agreed figure. In other words, the gasworks would not reap benefit from the removal of phenol unless they also achieved a satisfactory reduction of higher tar acids. Subject to the compliance with the latter standard, the price for treating a unit volume of liquor would drop in step with the O.A. as in the system devised at West Bromwich.

Mr. **J. P. Barnes** (Walsall) said that, although so successful, the treatment of the liquor was going to involve a high charge and a heavy load at the sewage works. What could be such valuable by-products were so expensive to oxidise before being suitably conditioned for discharge to waste. A plant for disposal of gas liquor other than by admixture with sewage had been described by T. Nicklin, and it had been claimed that such a plant could be operated at a reasonable profit.

Mr. **T. H. Summers** (Water Pollution Research Board) said that similar experiments to those carried out by Mr. Clifford were being made at Stivichall, Coventry, by the Water Pollution Research laboratory, but spent gas liquor was being used. As at Rea Hall, the liquor was added to the settled sewage immediately prior to filtration, and in some respects the results so far obtained compared with those given in the paper. One feature common to both experiments was the weak nature of the sewage treated, and the fact that the filters were underloaded before the experiments began. Most of the extra load due to the liquor was therefore easily absorbed by the filters, and it would appear that, in experiments to assess the effect of spent liquor on the treatment of sewage in filters, they should be working almost up to capacity before the spent liquor was added.

REPLY TO DISCUSSION

Mr. Clifford, in his reply, remarked that Mr. Evans had raised the question of the comparative effect on the dissolved oxygen in the river of effluents from electric power stations and untreated gas liquor. The author thought there was little doubt that the toxic effects of gas liquor retarded river recovery far more than the diminution of dissolved oxygen by temperature increase. Having discussed the question of foam development with Mr. Evans on previous occasions, he believed that there was some uncertainty as to the exact constituent of the liquor responsible. It did, however, provide an undesirable characteristic, and the formation on the surface of the filtering medium caused some concern, because when the foam disintegrated, a dark brown precipitate remained, a feature not conducive to the efficient operation of the plant. The question of direct discharge to the sewers of gas liquor would receive serious consideration when the pre-treatment plant at Swan Village was in operation.

Mr. Evans had referred to the effect of the dissolved oxygen returned to the filter via the recirculating water. Some work had been done on this, and it was found that this dissolved oxygen diminished the load of the gas liquor by about 10%.

The author thought Mr. Tomlinson's contribution was specially valuable in view of his association with the work carried out at Minworth, but his comment that double alternating filtration produced better results than recirculation was not borne out at West Bromwich up to the present. It must be appreciated that the primary filter of the double alternating process would be required to treat gas liquor at twice the loading of the recirculation filter in order to equal the loading per cu. yd. of filter. Thus, if the recirculating filter in the experimental plant was treating 0.4 gal. of gas liquor per cu. yd. per 24 hours, the primary filter of the double alternating system would be required to treat a dose of 0.8 gal. They had not yet subjected the alternating filters to this severe test, and on present indications he doubted their ability to cope with such a rate. He thought it would be most interesting to compare the work of the W.P.R.B. now in progress at Coventry with the results obtained at West Bromwich. Regarding Mr. Tomlinson's comments on the finely divided suspended matter discharged from the filters at Coventry, this had not been a characteristic at West Bromwich.

He felt that the contact time experiments had established with some certainty that coloration of the effluents was much less marked with immediate dosing of liquor, but apart from this it was too early to give conclusions.

Mr. Clifford said that Mr. Britton's contribution was a very frank criticism of the lb. O.A. loading method of treatment charge, and he felt it would be necessary to review the cost of treatment in the light of information gained when it was possible to assess costs from actual work on the purification of pre-treated liquor.

In reply to Dr. Jenkins, who questioned the possibility of increasing the 100 lb. load to 250 lb. O.A., if the increases were entirely due to sewage, the speaker said that during the past few months the sewage dose had been increased from 116 gal. to 137 gal. per cu. yd. per day, a 15% increase in sewage loading, and a consequent increase in the lb. O.A. loading due to sewage.

Having regard to B.O.D. figures, the speaker gave the following:

Sewage, excluding gas liquor	26.0
Tank effluent, excluding gas liquor	18.0
Final effluent, No. 7 experimental filter	0.8
Final effluent, ordinary filter	1.0

(parts per 100,000)

The proposed controlled investigations to be carried out by the Birmingham Tame and Rea Drainage Board on the behaviour of the different constituents of gas liquor during purification should prove invaluable.

Mr. Clifford said Mr. Hawthorn, who, throughout the negotiations had shown an understanding of the difficulties and a desire to assist in every possible way, emphasised the cost of liquor transportation by canal. It should, however, be appreciated that if the liquor were discharged to the sewers they would be limited in ability to control the dose of liquor to the filters operating under various methods, and would in all probability be overdosing the alternators and recirculators. In effect, the present arrangement was an endeavour to treat a maximum quantity of liquor by the plant now available, and this could only be done by the direct control dosing of liquor to the individual filters. The method had also enabled them to collate information which would otherwise have been impossible. With the complete installation of the recirculation principle to the remainder of the filtration plant serious consideration would be given to the discharge of pretreated liquor to the sewers.

Mr. Summers had referred to a feature common to Coventry and West Bromwich, that the filters were underloaded before experimental work began. The speaker felt that the West Bromwich filters, treating 116 gal. of industrial sewage per cu. yd. per 24 hours, were not underloaded, but the reverse. Mr. Tomlinson referred to the Coventry experimental plant as treating an average of 60 gal. per cu. yd. of purely domestic sewage, a difference of some 56 gal.

Referring to the issue of licences for steel for the home market, Sir Ellis Hunter, President of the British Iron and Steel Federation, speaking in his capacity as chairman of the company at the annual meeting of Redpath, Brown & Co., Ltd., Edinburgh, said that the steel position, except in certain materials which the company did not use, was no longer really stringent. There was, in fact, he said, undue emphasis on shortages of steel. 'Habits of mind created by the acute scarcity which existed two or three years ago—a scarcity which has now passed—tend to persist in official quarters and are apt to result in some projects being unnecessarily diverted to other forms of construction.' The transfer of the undertaking to the State, he added, could not benefit the structural engineering industry, and 'would almost certainly adversely affect its prospects.'

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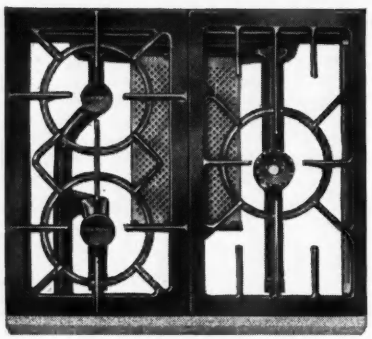

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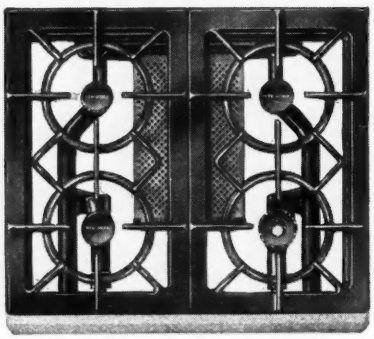

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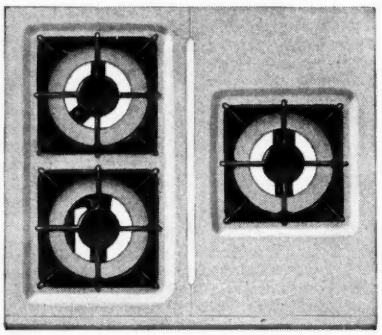

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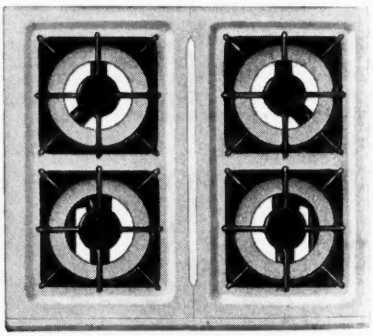

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DOMESTIC WATER HEATING*

By J. C. WESTON, Ph.D., A.Inst.P., A.M.I.H.V.E.,
Building Research Station

EDITOR'S NOTE :—**In this paper methods of domestic water heating are described and their distribution through the country noted. The amount of hot water used and methods of heating are given and it is suggested the for design comparisons of appliances intended for use in houses around 1,000 sq. ft. area, the consumption of 150 gallons per week at 140° F. should be assumed for gas and electrical appliances and 250 gallons for solid fuel appliances. The design figure of 350 gallons at 140° F. per household per week is suggested for use where hot water is to be provided from a central source.**

PROVISION of adequate hot water supplies was referred to by the Egerton Committee in its report as 'a necessity in every home,' but recent surveys have shown that only about one-third of the houses in this country have a hot water supply piped to kitchen sink, wash basin, and bath, and two out of every five households have kettles or pans on the stove or a solid-fuel copper, as the only method of water heating. That is, 5½ mill. households have water heating arrangements which cannot in any sense be considered adequate. Clearly there is scope for improvement in existing dwellings and for the maintenance of reasonable standards in new housing. This report aims to provide the technical information required for deciding the methods of water heating to be used in any particular case. The primary necessity is to ascertain what existing conditions are, and what the demands for appliances and amount of hot water are likely to be. This type of information is only obtainable by the methods of Social Survey in which a sample of households (say, 3,000 to 5,000) is taken in such a way as to be representative of the whole population. Such surveys dealing with the distribution of appliances and the use of hot water have recently been completed. The cost of providing varying amounts of hot water by different methods is obviously important and here the data obtained from experimental houses at the Building Research Station have been used. The paper is mainly concerned with hot water supplies provided by appliances in individual dwellings and especially in houses around 1,000 sq. ft. area.

Methods of Hot Water Heating

Hot water is required for use in the kitchen, for laundry and washing-up, and also for washing and baths in the bathroom. The same appliance may be, and in fact usually is, used to supply water to the sink, wash basin, and bath, but the surveys have shown that only 36% of households (defined as 'a group of people living in the same dwelling and sharing the same housekeeping unit') have hot water piped to all three points. Forty-four per cent. of households do not have hot water piped to any point and must rely on kettles or pans or coppers as their sole means of water heating. Furthermore, only 54% of households have access to a bathroom. This background information should be kept in mind when discussing the methods of water heating.

Solid Fuel

Solid fuel appliances are by far the most widely used, being installed either alone or together with gas or electrical appliances in 64% of households. Gas is used in 37% of households and electricity in 10%, but whereas gas is frequently used alone (17%) electricity is rarely (2%) the only source of hot water supply.

The copper, set pot, or wash boiler is the most common solid fuel water heating device, but is now more or less obsolescent, as is shown by the fact that although 33% of pre-1914 houses have such appliances, only 14% of post-1918 houses are so equipped and such devices are now rarely installed. Most solid-fuel cookers can be supplied with boilers and these are sometimes of sufficient size to permit of the addition of a small area of radiator for space heating. As there is little control of the temperature of the hot water it is desirable to use an 'indirect' system, in which the hot water from the boiler is passed through a calorifier in the storage tank and does not mix with the stored hot water. Twenty-four per cent. of households use some version of solid-fuel cooker for water heating. Independent boilers (8% of households) are usually of the circulator type, and though not generally employed, an 'indirect' system is desirable, as here again there is not usually adequate control of the water temperature to prevent occasional over-heating with consequent scale formation. In solid fuel storage water heaters, the storage tank is mounted above and around the fire-box and serves as boiler as well as storage vessel. Here, of course, the system is intrinsically direct, and, therefore, not suitable for areas where scale formation is likely to be serious. Many of the smaller independent boilers are sufficiently large to allow the addition of a small area of radiator, while the larger boilers of, say, more than 25,000 B.Th.U. per hour rating are intended as central heating boilers. Such boilers usually have thermostatic control of the water temperature governing the supply of combustion air to the fire. In some types, the air for combustion relies on natural draught and in others forced draught is used. This type of boiler can be either magazine or manually fed, but where a magazine is used the appliance is likely to be selective in the type of fuel which it will consume, and is usually restricted to sized anthracite. The satisfactory use of such boilers for water in the summer when space heating is not required depends on their having a low rate of fuel consumption when slumbering.

Water heating is frequently provided (13% of households) by the addition of a back boiler to an open fire and stove. Here again an indirect system should be used. Since the space heating appliance would normally have to be lit in the summer to provide hot water, it is desirable to supplement it with some method of auxiliary water heating for use when space heating is unnecessary.

The survey shows that only a few households (1%) have hot water laid on ; most of these being presumably either in blocks of flats or district heating schemes.

The gas copper for laundry use is the most generally used gas appliance (30% of households). Of the appliances for more general use, the instantaneous heater—either single or multipoint—is the most popular (12%).

Gas storage heaters are used either as sink heaters, in which the storage capacity is limited to between two and five gal. ; or as multipoint heaters when the storage is 12 gal. or upwards.

Electrical appliances are found in 11% of households and are divided almost equally between wash boilers, immersion heaters, and self-contained storage heaters. The immersion heater is, strictly speaking, a storage heater, but is installed in a tank which may be heated by another appliance such as a back boiler or independent boiler, while the self-contained storage heater is a factory-made appliance in which tank, heating elements, and insulation are assembled as a complete unit. Storage heaters are usually thermostatically controlled, but with the immersion heater, control may be omitted and the switches manually operated. Immersion heaters can be installed in existing tanks either horizontally from the side or vertically from the top or bottom, the vertical fixing providing the most rapid heating of the water in the upper part of the storage vessel. Storage heaters are available in sizes suitable for sink

* From a paper to the Institution of Heating and Ventilating Engineers, January 9th, 1950.

use, with a capacity of only 2 to 5 gal., or in larger sizes suitable for multipoint use having a capacity of more than 12 gal. In some of the larger storage heaters, a built-in cold water cistern is included as part of the unit. As with gas storage heaters, 'divided storage' can be provided with the use of two heating elements, one at low level for bulk use (rated around 2½ kW), and a similar one at high level for sink use (0.5 kW). To achieve more rapid heating of the water at the top of the storage vessel, the so-called 'circulator' type was introduced. This has a vertical element surrounded by a draught tube which enables increased stratification to be obtained. Instantaneous electric heaters have been made for sink use, but they are of necessity so heavily rated as to put severe demands on the electric wiring in the house, and such appliances are not popular with supply undertakings.

The Use of Hot Water

Various estimates have been made of the amount of hot water required by a household, but there does not appear hitherto to have been any really direct information of actual consumption and temperature at which water is used in practice. It seems generally accepted as desirable that the temperature for hot water available at wash basins and baths should be around 105° and 110° F., and at the kitchen sink 140° F. On the question of the desirable consumption, there is much dispute, arising in part from the failure to appreciate that consumption is much more likely to be governed by the cost and convenience of the supply than by any objective standards of desirability, even supposing that it were possible to decide such standards. It seems to be widely agreed, however, that consumption in excess of 150 gal. per week at 140° F. is necessary for a family of parents and two children, and the Egerton Committee recommended that installations should be capable of supplying 250 gal. at 140° F. Apart from such considerations, there are now data on actual consumptions of hot water with different heating arrangements available from the experimental houses at the Building Research Station. Although the information covers only a limited number of houses, it has been obtained over a long period of time, and in some cases information is available on the consumption of hot water by the same family using different appliances. The method used to record water consumption involves the use of a specially designed B.Th.U. meter, which records not the 'gallons of hot water,' but the B.Th.U. contained in it.

The houses in which these measurements were made are the eight at Bucknalls Close and the 20 at Abbots Langley. The Bucknalls Close houses have thermostatically-controlled immersion heaters fitted horizontally at low level in a rectangular tank of 40 gal. nominal capacity lagged with ¾ in. laminated asbestos board. The magazine-fed, anthracite-burning boiler provided space and water heating as required. During the winters of 1947-48 and 1948-49 the tenants generally used the solid-fuel appliances for water heating, while in the summer of 1948 immersion heaters were used in all cases. In the summer of 1949 some tenants used immersion heaters and some solid-fuel appliances.

The mean weekly consumption of water at 140° F. for the eight houses during the winters of 1947-48 and 1948-49 was 245 and 223 gal., and for the summer of 1948, 179 gal. It will be remembered that during this summer the tenants were using electricity for water heating. For the houses which used electricity during the summer of 1949 the mean consumption was 166 gal., while in the houses using solid-fuel boilers the consumption was 223 gal. It would appear from these figures that, where the same heating arrangements are used in summer and winter, there is little seasonal variation in consumption, but with electric immersion heaters the hot water consumption is substantially below that with the solid-fuel boilers. Statistical tests confirm this impression; there is a highly significant (better than 1% level) difference between water consumption in the summer of 1948 and that in the preceding winter, and also between the consumption in houses using electricity in 1949 and the consumption in the same houses in the preceding winter. Furthermore, the difference in consumption of those tenants using solid fuel in the summer of 1949 and the preceding winter is not significant. The reason for this drop in consumption when electricity is used in these particular houses seems to be due to the characteristic variation of fuel consumption with hot water consumption. An increase in water consumption produces only a slight increase in fuel consumption—and consequently cost—when solid fuel is used, but when electricity is used an increase in water consumption brings a corresponding increase in electricity consumption, and, of course, cost, and places some constraint on the tenants' usage.

From an analysis of gas consumption, among households using gas for cooking and water heating and having no other means of water heating, Purkis concludes that the average weekly usage is as low as 70 gal. It would appear from the same report that under these conditions some water is being heated on the gas cooker, but even allowing for this the consumption is not likely to be much above 90 to 100 gal. per week. The reason for these rather low figures is not entirely clear, though it may be that households having only gas for water heating may include an unduly high proportion of the lowest income groups, and certainly the sample includes all types of property and all vintages of appliance. There can, however, be little doubt as to the validity of this figure for the particular group to which it refers.

There is a range of consumption from 90 to 350 gal. per week—the latter with district heating schemes—and individual cases will occur even outside this range. It should be noted, however, that although at first sight the 350 gal. consumption appears desirable it must be remembered that the tenants are, in fact, paying for this amount of water in their fixed weekly charge. For low income groups the ability to adjust consumption and consequently financial expenditure in relation to their income is a very important feature.

From the point of view of designers it is desirable to have some basis for comparison of water heating appliances and systems, and in the light of all the information it is suggested that for gas and electrical appliances a consumption of 150 gal. at 140° F. per week per family should be taken as the standard, and for solid-fuel appliances 250 gal. Attention should be paid, however, to the production of appliances or groups of appliances designed to operate at high efficiency over a wide range of usages, from, say, 50-500 gal. per week to meet the requirements of tenants in different income groups. Finally, as a design figure where hot water is supplied from a central source a figure of 350 gal. at 140° F. per week per household can be taken.

Costs

With gas at 1s. therm, electricity ½d. kWh, and coke at about 90s. a ton, the cost of providing 200 to 250 gal. of hot water during summer with any of these fuels is likely to be in the region of 3s. to 4s. There will, of course, be differences between different installations, but assuming that the installation conforms with present standards and the method of operation is broadly similar to that employed by the tenants in the experimental houses then the cost should be within this range. If anything, solid fuel is slightly more expensive than gas or electricity for summer water heating, but since a heated airing cupboard is included in the cost with solid fuel, and not necessarily with gas or electricity, the difference tends to be small. For consumption in excess of 250 gal. per week during the summer, solid fuel is likely to be cheaper than gas or electricity with the above prices and for consumption below 200 gal. the cost by electricity or gas is likely to be lower than by solid fuel.

The United States is to hold its first International Trade Fair in Chicago from August 7 to 19, 1950, and of the nearly 1 mill. sq. ft. of space, two-thirds has been reserved for non-American exhibitors, mainly from Western Europe. U.K. exhibitors may obtain general information about the Fair from Exhibitions and Fairs Division of the Board of Trade, and can book space through Mr. A. P. Wales, of 16, Shelton Street, London, W.C.2.